# *DEVELOPING THE EXPERTISE OF INFORMATION SYSTEMS STUDENTS IN REAL WORLD CAPSTONE PROJECTS*

**Gilbert Ravalli**

**Faculty of Science, Engineering and Technology**
**Swinburne University of Technology**

**This dissertation is submitted for the degree of Doctor of Philosophy**
**August 2015**

# DECLARATION

This thesis contains no material which has been accepted for the award to the candidate of any other degree or diploma, except where due reference is made in the text of the examinable outcome. To the best of the candidate's knowledge it contains no material previously published or written by another person except where due reference is made in the text of the examinable outcome. Where work is based on joint research or publications, the relative contributions of the respective workers or authors is disclosed.

Signed:______________________________________________________

Gilbert Ravalli

# ABSTRACT

Employers are looking to employ Information Systems graduates in areas requiring analysis and design. While these graduates will have relevant academic technical knowledge and skills there can be significant gaps in ability between these graduates and professional analysts. This is because there is a great deal of conscious and unconscious knowledge that is acquired through working in real world environments with all its complexities. There is a need by employers for graduates who can become productive more quickly while universities feel the pressure to develop graduates who are readily employable.

One way to approach this challenge is to compare how current emerging graduates think and behave and compare that to expert analysts to determine the most significant gaps. There is academic literature on novice and expert differences in the areas of analysis and design in information systems (and related areas). However, within this literature the participants' levels of knowledge and experience are wide ranging and many studies are focussed on a very small area of interest and set in laboratory style conditions very different to real world practice. The result is a body of knowledge that is quite fragmented and, it can be argued, with results that sometimes may not give much insight into how experts think and behave in a professional capacity. Hence, we do not have a very clear picture and understanding of the key areas of difference between emerging graduates and experts in situations similar to real world practice. However, if we can determine those gaps we can then develop ways to eliminate or reduce them.

The questions that were posed in this research related to

- the areas in which students demonstrated difficulty or gaps in their knowledge, skills or attitudes
- how these difficulties or gaps of students compared with the novice-expert literature
- the recommendations that could be can made for improvement

The overarching philosophical framework for this study was based on the concept of application of judgment and the development of expertise and, in particular, its development in Information Systems analysis and design. The study involved four industry based IS analyst experts and final year students.  Students were placed into small teams of three or four to work on projects working directly with a client with a real world problem or opportunity to which they needed to find a satisfactory solution.

Each team was individually supervised by well qualified current or former professionals in information systems analysis and design.

Each of the four expert supervisors was interviewed on multiple occasions and asked to describe their perceptions of how students were coping with their project and the difficulties and problems they were having. Students provided responses in semi-structured journals at three different points in their project to obtain their perceptions about aspects of the project that would be relevant at that time.

A holistic approach was taken to explore a wide range of themes so that those areas which were most problematic for those students would emerge. The research was exploratory in nature and a qualitative approach was deemed most appropriate since the aim was to develop understanding for the purpose of later finding ways to improve students' abilities. Qualitative content analysis was selected as the methodology most aligned with addressing and answering the research questions.

Some of the key areas that the expert supervisors perceived as difficulties for students were in client relations and their attitudes to and expectations of clients; treating a project as an extended version of an academic assignment with its attendant latent assumptions and attitudes; not being proactive enough in driving the project from the start through to a satisfactory conclusion and difficulty in taking an holistic view in their understanding of the clients problem and the potential solutions.

Students' responses at various stages of the project suggested that they were often not aware of what they didn't know or had misunderstood and often had weak control strategies regarding issues such as problem understanding or project progress. Students appreciated the input of their supervisors in helping them explore or reassess their understanding at various times in the project. When students went "off track" from a project management perspective or otherwise had become stuck in some part of their work they again appreciated that supervisors became aware of their situation and were able to guide them appropriately. By the end of the project students expressed the importance of problem understanding, gathering requirements early and good communication and a deeper appreciation of the need for adequate project management and good leadership.

By combining the analyses from students' journals and expert supervisor interviews it was possible to derive a comprehensive set of issues identifying the areas in which students were most deficient when compared with their expert supervisors and therefore could be improved. Recommendations to deal with each issue were developed using three sources: the academic literature across a wide variety of fields in higher education which involved capstone projects or other relevant project based experience; advice through informal discussions with the expert supervisors and other academic colleagues involved in capstone projects and, finally, this researcher’s own knowledge and experience. The result is that each issue identified is addressed by one or more recommendations to reduce or avoid the issue. Some of these recommendations are to be implemented during the conduct of the project while others should be implemented earlier in a student’s course of study.

The results of this study will be of value to those who conduct IS analysis and design capstone projects; IS educators teaching IS analysis and design prior to beginning capstone projects; for educators who conduct capstone projects in other fields and those who employ, manage, supervise or mentor new graduates involved IS analysis and design in a professional capacity.

# PUBLISHED PAPERS RELATED TO THIS RESEARCH

All papers listed here were peer reviewed.

Farrell, V., Farrell, G., Kindler, P., Ravalli, G., & Hall, D. (2013). *Capstone project online assessment tool without the paper work*. Paper presented at the Proceedings of the 18th ACM conference on Innovation and technology in computer science education, Canterbury, England, UK.

Farrell, V., Ravalli, G., Farrell, G., Kindler, P., & Hall, D. (2012). *Capstone project: fair, just and accountable assessment*. Paper presented at the Proceedings of the 17th ACM annual conference on Innovation and technology in computer science education, Haifa, Israel.

Ravalli, G., & Stojcevski, A. (2011). *Students' judgment in initial phases of industry projects.* Paper presented at the Proceedings of Aligning Engineering Education with Engineering Challenges, 3rd International Symposium on Project Approaches in Engineering Education (PAEE2011), Lisbon, Portugal.

Ravalli, G., & Stojcevski, A. (2011, 27-30 September 2011). *Students perception of capstone projects.* Paper presented at the Proceedings of the 1st World Engineering Education Flash Week (WEE2011), Lisbon, Portugal.

Ravalli, G., Stojcevski, A., & Ekambaram, P. (2012,). *Student approaches to real world problem identification in information technology projects.* Paper presented at the Proceedings of 'PBL and the problematization of teaching and learning', the 3rd International PBL Symposium 2012, Singapore,.

# ACKNOWLEDGEMENTS

I would like to offer my sincere appreciation to Professor John Grundy and Dr Vivienne Farrell who were my supervisors in the later stages of my thesis. They both provided wonderful and timely support with my work and great encouragement. I would also like to acknowledge the support of previous supervisors over time Associate Professor Greg Heath, Professor Alex Stojcevski, Dr Adi Prananto, Associate Professor Palaneeswaran Ekambaram  and Professor Judy McKay.

# CONTENTS

# LIST OF TABLES

# List of Figures

# List of Abbreviations and Acronyms

| | |
|---|---|
| BABOK® | Business Analysis Body of Knowledge |
| IS | Information Systems |
| ISAD | Information Systems Analysis and Design |
| ISAPS | Information Systems Analysis Problem Solving |
| PG | Postgraduate |
| RE | Requirements Engineering |
| UG | Undergraduate |

# LIST OF APPENDICES

# 1 INTRODUCTION

## 1.1 Introduction

The aim of this research is to enhance our understanding of students' professional judgment in Information Systems analysis and design (ISAD) and with this deeper understanding suggest ways to better prepare them for professional life. It focusses on and interprets students' understanding of Information Systems analysis and design from the overarching concept of practical judgment and in particular from the perspective of the development of expertise in that area. The context of the study is capstone projects undertaken by final year Information Systems students dealing with Information Systems analysis and design problems. The students involved in these capstone projects are put into the situation of working directly with the business clients to understand, define and then work toward solving real world problems. They are expected to apply what they have learned in an attempt to arrive at an effective solution. This situation puts the client, the problem and any proposed solution in context and thereby provides a very realistic environment in which students must work. It is hoped that this research will not only improve the teaching and learning of ISAD but also add to understanding about the development of expertise in ISAD.

The ISAD activity assumes that the solution design will, in large part, be based around drawing from a range of information technology artefacts which are available or can be modified or developed to meet the client's needs. Selection of solution designs which are deemed to be satisfactory are subject to a variety of constraints which will exist within the client's problem environment e.g. economic, schedule, technical, organisational, cultural and so on.

In Information Systems analysis and design, as in other professional fields, developing one's ability to solve practical problems is accomplished through direct experience in dealing with practical problems in real world settings. It is not suggested that formal training largely in academic environment is not necessary. In professional fields one needs to learn the underlying knowledge, skills and practices of the profession. However, these are typically presented to the learner in a top down manner with standard solutions to standard problems together with guidelines and rules as to their application. This can present an idealised and simplified picture of the practice. What students have not yet developed to any great degree, if their experiences solely within the academic world, is practical judgment.

The particular terminology "Information Systems analysis and design", ISAD, is used because we would like to differentiate it from other activities performed by practitioners also involving information technology and performing some of the same or similar tasks. These other activities include, for example, requirements engineering (Neill & Laplante, 2003; Nuseibeh & Easterbrook, 2000; Pohl, 2010), requirements analysis and systems design (Maciaszek, 2007), business analysis (Brennan, 2009; Elo et al., 2014) and systems analysis and design (Satzinger, B., & Burd, 2012; Shelly & Rosenblatt, 2011) amongst others. It will be argued later that the ISAD perspective taken in this thesis has particular defining characteristics which differentiate it from these other activities.

The next section of this chapter begins with a discussion about ISAD as a professional activity. It then discusses some of the problems in teaching and learning ISAD. The research aims and questions are addressed followed by the project scope and a brief overview of the project design. The chapter concludes with an overview of the thesis structure.

## 1.2 The ISAD activity and wicked problems

The term "wicked problem" was popularised in the 1973 article "Dilemmas in a General Theory of Planning" by Horst Rittel and Melvin Webber (Rittel & Webber, 1973). A problem can be complex and that may not have a simple method of solution but it could "tame" or "benign". With tame problems one can adopt the sequential approach of understanding the problem, gathering information, researching possible solutions and then finding the correct solution. However with a “wicked” problem Rittel and Webber suggest that one is dealing with interacting open systems in which the outputs to one system become the inputs to others. A change to one system affects others and confounds one’s view about cause and effect and is made even more complex when dealing with real people with their own needs, agenda, limited capabilities and understandings who are involved in any development activity.

According to Rittel and Webber (1973), in a wicked problem the information you need to solve a problem depends on the problem solver’s idea of the solution to that problem. One “*cannot understand the problem without knowing about its context; one cannot meaningfully search for information without the orientation of a solution concept; one cannot first understand, then solve*.” (Rittel & Webber, 1973) In order to fully define the problem so that every possible question could be anticipated in advance then one would need to enumerate every conceivable solution in advance. In real world problems “*there are no criteria for sufficient understanding and …. there are no ends to the causal chains that link interacting open systems*” (Rittel & Webber, 1973). It is always possible (though not guaranteed) that a bit more effort might uncover a better solution. Those professionals involved in fields such as requirements analysis and design (DeGrace & Stahl, 1990), architecture and engineering (Schon, 1983, 1987) and Information Systems Analysis and Design (ISAD) which is the context of this research are all in the business of solving “wicked problems”.

In the real world of professional practice, professional analysts cannot operate effectively solely on the basis of standard solutions to standard problems and using standard methods. They must develop practical judgment based on understanding and responding to the entire context of that situation. Context includes, but is not limited to, factors such as the organisation and stakeholders, cultural and historical factors and possible future scenarios. Judgment involves understanding what works and what doesn’t work in that environment. As one develops that judgment one becomes progressively more effective in understanding and solving problems. Professionals need to develop fluency in recognising and understanding the most relevant factors in practical situations, holistic thinking and an effective and adaptable way of tackling the problem solving task. Standard techniques and solutions must be adapted to suit the particular situation or new ones developed. Furthermore one needs to develop a set of attitudes and behaviours which are suited to that professional field.

In the case of ISAD, those stakeholders who are involved in the problem solving process involving an information system often have unclear objectives or objectives which may not be easily translatable into Information Systems terms. When analysts gather requirements from users, each user brings only their perspective and understanding of the overall system which is likely to be limited and possibly incorrect. Requirements may be conflicting and therefore need resolution (Chakraborty, Sarker, & Sarker, 2010). The criteria for success typically involve trade-offs among factors such as cost, time, and functionality and so on.

While performing the task of ISAD an analyst is often in the position of having to learn about an area with which they are not familiar, master its information needs to a high level of proficiency, offer solutions and in the process of doing so represent this knowledge and solutions in ways intelligible to a variety of stakeholders who may not necessarily be familiar with information systems concepts. ISAD is therefore a learning activity involving the analyst or the various stakeholders with whom the analyst must interact.

Given the difficulty and complexity of dealing with wicked problems, in practice the would-be problem solver stops working on the problem not for any reasons related to the problem directly but for the more practical external ones such as: "*he runs out of time, or money, or patience*" and eventually says, "*That's good enough," or "This is the best I can do within the limitations of the project," or "I like this solution," etc.* "" (Rittel & Webber, 1973)

In spite of this rather gloomy picture which has been painted about the wicked problems inherent in ISAD, it is clear by observation of the organisations around us that information systems are ubiquitous and while there are arguments about the contribution that these systems make to their organisations, overall they must be perceived by those in business to provide some notions of value or otherwise businesses would not persist in their use and further development (Melville, Kraemer, & Gurbaxani, 2004; Silvius, 2006; Tiernan & Peppard, 2004).

## 1.3 Issues involved in teaching and learning ISAD

Given the inherent difficulties involved in the professional practice of ISAD, it is probably not surprising that teaching ISAD is considered difficult by those who teach it and the students trying to learn it. Several issues have been identified in the literature.

Connolly and Begg (2006) state that students have difficulty handling vagueness and ambiguity; they also “*have difficulty analysing problems where there is no single, simple, well-known, or correct solution*”. They go on to say that while this may suitable for some aspects of the curriculum, they suggest that this approach “*tends to be problematic in the abstract and complex domain of database analysis and design*”.
Students have difficulty identifying of concepts of interest. When novices are presented a problem domain to consider, even a relatively simple one, they often have difficulty extracting items of interest. Aspects related to data modelling seem to be particularly difficult (Chilton, McHaney, & Chae, 2006). Similar issues arise in the area of object oriented analysis and design (Hadjerrouit, 1999; Yazici, Boyle, & Khan, 2001) and requirements engineering (Bubenko, 1995).
Students have difficulty handling complexity. When dealing with requirements analysis, for example, complexity is added rather than reduced with increased understanding of the problem and using metacognitive strategies (i.e. strategies in which one reflects on one’s own thinking and problem solving strategies and modifies them to more effective ones) are fundamental to the process (Armarego, 2002).
Students struggle with differentiating between implementation dependent and independent issues as needed in solution design. Students can find this difficult to grasp (Connolly & Begg, 2006).
Students lack of knowledge and experience means that they do not have the background of knowledge and intuition needed for effective problem-solving and coping with new problems (Armarego, 2002).
The issue of effective and ineffective mental models which help or hinder learning is well understood. For example in the area of science (Bransford, Brown, & Cocking, 2000, p. 179) states that “*Before students can really learn new scientific concepts, they often need to re-conceptualise deeply rooted misconceptions that interfere with the learning … people spend considerable time and effort constructing a view of the physical world through experiences and observations and they may cling tenaciously to those views – however much they may conflict with scientific concepts – because they help them explain phenomena and make predictions about the world*”.
The concept of an information system as understood by students, academics and practitioners has been studied using a phenomenographic approach by Cope and others (Cope, 2002, 2003; Cope, Horan, & Garner, 1997). Six levels of understanding about an information system were found. The levels are arranged hierarchically and each higher

level incorporates the understanding of the levels below. The lowest level views an information system simply as a user interface (e.g. a personal computer) and the ability to make simple queries on a static database. An intermediate level (level 4) views the information system as a computerised multi-user system accessing a dynamic database and which serves the organisational functions of one organisation; while people used the system, there were not considered as part of the information system. The highest level (level 6) views the information system as a social system operating across the all functions of an organisation in which people use and manipulate information as needed. Information technology was seen as something imbedded within the organisation and used to support the information system tasks. (Cope, 2002, 2003) suggest that students needed learning experiences which guide students to the higher levels of understanding and that this should not be left to chance.

Similarly students may have inappropriate or naïve mental models of a computer as (Ben-Ari, 2001, p. 45) found in the area of computer science education. Ben Ari states "*intuitive models of computers are doomed to be non-viable. At most, the model is limited to the grossly anthropomorphic giant brain, hardly a useful metaphor when studying computer science. (Pea, 1986) gives the name "superbug" to the idea that a "hidden mind" within the programming language has intelligence.*" These ineffective models hold back the progress of students. To overcome this, Ben Ari suggested that, "*(a) models must be explicitly taught, (b) models must be taught before abstractions, and (c) the seductive reality of the computer must not be allowed to supplant construction of models.*"

Satzinger, Batra, and Heikki (2007) reported on the panel discussion at the Americas Conference on Information Systems (AMCIS) 2007 conference which evaluated how recent industry trends impact the coverage of the systems analysis and design (SA&D) course. Of particular relevance was the following, "*One of the clearest messages from the audience at the end of the panel was the need to identify and focus on the core immutable principles and skills of SA&D*". The situation here in Australia is possibly worse since North America at least has an agreed national curriculum for the study of Information Systems but no such agreed curriculum exists in Australia.

## 1.4 Teaching approaches to ISAD

According to Connolly (Connolly & Begg, 2006) teaching approaches tend to adopt a style of teaching *about* ISAD but it is suggested that these do not appear to be very effective. For example, in the North American approach to teaching information systems related courses Connolly and Begg (2006) state, "*this approach is based on a normative professional education curriculum, in which students first study basic science, then the relevant applied science, so that learning may be viewed as a progression to expertise through task analysis, strategy selection, try-out, and repetition*". They go on to say that is particularly a problem in database analysis and design which is a fundamental subset of the area ISAD.

Schon (Schon, 1983, 1987) makes several points about design which are relevant to ISAD teaching. Firstly, he suggests that it cannot be taught by describing the process but instead must be learned through practice. Secondly, it is a holistic skill and the parts cannot be learned in isolation. Thirdly, it depends on having an understanding of which properties are desirable and undesirable in the context of the problem space and this can only be learned by doing. What we can take from this is that it is highly advisable to provide learning situations which are sufficiently realistic so that students will learn something significant about real world practice.

Mathiassen and Purao (2002) provide useful insights in Information Systems development and the training of budding information systems developers. They suggest that, based on survey evidence, teaching in this area is biased "*towards a prescribed, rational, top-down approach to systems development and an emphasis on documentation*". Their evidence suggests that methodologies ("cookbooks" on how to build information systems) which are commonly taught to students as how systems development occurs are not considered critical to development; in practice, experts pick and choose from them as needed. A more critical aspect identified as leading to greater success were the behavioural differences between successful high and low rated analysts. These differences related to "*analogical reasoning, the setting of goals and formulation of strategies while maintaining flexibility, managing of emerging hypotheses and actively dealing with the interface between analyst and user*". While Mathiassen and Purao (2002) do not deny that a solid understanding of the basics is important, how the analyst thinks about and operates within the real world situation is more critical than what they know. Their recommendation was to use realistic and reasonably complex projects as laboratories for reflective learning. Students would be able to apply standard methods they have learned and also to evolve those methods to suit the project needs; develop and reflect critically on the communities of practice developed within projects and to develop collaborative skills.

## 1.5 The Problem

Given the discussion above about the difficulties involved in ISAD in practice and the observed issues that students have while studying ISAD, there appears to be a significant gap between the actual knowledge and skills of students demonstrate and the knowledge and skills that are required by ISAD professionals. As will be demonstrated later in this thesis the literature related to the development of expertise in IS analysis and design is probably best described as both limited and diverse. However there is reasonably relevant literature beyond information systems in areas categorized as business analysis, requirements engineering and software engineering. Sometimes resonances and insights can also be found even further abroad in areas such as design, engineering and business.

When searching for differences between students and professionals using keywords such as “novice-expert differences” will draw out relevant articles. As will be discussed in more detail later, often the distinction in these articles is simply between two arbitrary levels i.e. “novice” and “expert”. There are no commonly agreed definitions across the literature as to the knowledge and skills of the novice or expert. These terms are used typically in a relative sense within each article to describe some individuals who are significantly superior to others according to some criteria decided by the researcher. There is very little literature around the idea of a development path in terms of knowledge and skills and whether the development takes place steadily or through sudden leaps or a combination of both as someone moves from raw beginner to a high functioning professional – “the expert”.

S. E. Dreyfus and Dreyfus (1980) suggested a general five stage model describing the mental development of expertise. As will be discussed later, if one applies the model to ISAD, students in Capstone projects have already progressed to some degree along the path of developing their expertise in ISAD through having learnt the basic concepts and the standard problems, solutions and techniques and applied them in relatively straightforward situations. According to the Dreyfus model they have passed through the model's novice and an advanced beginner stages and are entering the competency stage in which they now must begin to apply what they have learnt in the real world. This corresponds to the development of practical or professional judgment.

Some factors which hinder the development of expertise are limitations as to the extent of experience, a lack of desire to improve, insufficient or inappropriate guidance toward improvement or insufficient focus on learning. If the appropriate learning environment is created which provides the relevant experience and guidance then the learner has the opportunity reach new levels of expertise if they have sufficient desire and focus on learning. It was with these ideas in mind that the Capstone project environment which was established in this study (and still continues in large part) was designed to provide students with the opportunity to work on real world problems with real world clients so as to develop their practical judgment and hence expertise in Information Systems analysis and design.

## 1.6 Research aims and questions

### 1.6.1 Research questions

The basic research question is: *How can the professional judgment of final year Information Systems students be improved to better deal with Information Systems analysis and design projects that involve real world problems and clients?* In order to focus and scope the project, this broad question has been broken down into the following sub-questions:

- What aspects of professional judgment in ISAD do final year Information Systems students demonstrate difficulty or gaps in their knowledge and skills when dealing with Information Systems analysis and design projects based on students' reports and the observations of their expert supervisors?
- How do the difficulties or gaps in knowledge and skills of students determined as a result of this research compare with the literature on novice-expert differences in ISAD and educational literature on students studying ISAD?
- What recommendations can be made which could enhance Information Systems students' professional judgment and development in ISAD?

### 1.6.2 Study Scope and Design

The students who are the subject of this research were final year students studying Information Systems or similar Information Technology courses. They were undertaking capstone projects involving ISAD with real world clients and attempting to solve a real world problem. The focus of the research was on the knowledge and skills of students and their ability to deal with real world clients and the difficulties they encountered as they worked with their clients in a consulting type role. The intention of the study was to develop a clear and detailed picture of students' understanding which could be used to guide future students' development by showing or suggesting what it was important for them to know or learn and the skills that needed to be developed. Students were placed into small teams of three or four to work on projects and each team was individually coached by current or recent professionals in the IS development area. These particular individuals had recognised professional experience and accomplishments in ISAD and were invited to participate in this research because of their expertise in the area.

The research aimed to develop a deep understanding of students' perceptions as they progressed through their projects but in particular where they had most difficulties. The intention was to take a broad brush approach and to cover a wide range of themes (e.g. problem understanding, client relations, teamwork, etc.). The research was intended to be exploratory in nature and aimed at determining the perceptions of both students and their supervisors and a qualitative research methodology was deemed to be the approach that would most suitable in terms of developing understanding.

Students were asked to respond to sets of open ended questions across a wide range of themes as part of semi-structured journals to which they responded at predefined stages during the conduct of the project. Their responses were recorded and a qualitative content analysis performed after the project was completed. The expert supervisors were interviewed on multiple occasions, the interviews transcribed and a qualitative content analysis performed to determine their different perceptions as to how students handled the projects and the advice they provided to students. With the two sets of perceptions it was possible therefore to compare and contrast students' understanding and judgments with those of the expert supervisors.

The approach was directed or deductive (Hsieh & Shannon, 2005) in that there was already some pre-understanding (Stenbacka, 2001) of the potential issues facing students from a body of knowledge regarding differences between novices and experts in the area of ISAD as well as first-hand experience from professionally experienced supervisors of students. However, while this pre-understanding guided the issues to probe, the questions that were developed were relatively open-ended so as not to constrain or bias the responses. This was especially so with supervisor interviews. Journals and interviews were subsequently analysed using an inductive approach so that concepts emerged from the data.

By obtaining this data during the course of the project (in contrast to, for example, obtaining it at the end of the project), the belief was that the validity of findings would be enhanced i.e. that a more authentic and detailed view of difficulties and confusions could be captured because they would be fresh in the minds of the participants. Asking for responses significantly after the events occurred risked that ideas, misunderstandings and emotional reactions to events could be forgotten or revised in hindsight.

By combining the results of the analyses from students and supervisors and by making use of findings and suggestions in the literature from other researchers who have conducted similar types of project based work, recommendations have been made as to how to improve or facilitate students' professional development in ISAD.

## 1.7 Overview of thesis structure

Chapter 2 discusses the idea of judgment. It differentiates between classical notions of judgment based purely on logic and facts from professional workplace judgment in which judgments must be made with limited resources in complex and evolving environments compounded by personal, social and political factors. The position is posed that classical notions of judgment are about solutions that are technically correct while professional and workplace judgment is about arriving at practical and effective solutions. The chapter then goes on to introduce the idea that experience can guide one's judgments in real world problems and that developing expertise in an area can lead to lead to more effective judgments and hence to increased likelihood of arriving at practical and effective solutions.

Chapter 3 begins with a discussion of the activities involved in Information Systems Analysis and Design and then suggests that real world practice is a much more chaotic and iterative activity than is typically portrayed. It suggests that a comprehensive model from management science on strategic decision making provides a better basis for thinking about ISAD. It also suggests that the design aspect of ISAD, while acknowledged, is not appreciated sufficiently. The chapter then discusses and suggests a set of core areas of knowledge and skill involved in ISAD. This work is then built upon by reviewing the literature on novice-expert differences in ISAD (and other related areas) to suggest the qualities of knowledge and skills demonstrated by ISAD experts. It then proposes that there are particular specialised areas of knowledge and skill which should differentiate ISAD professionals from other professionals in similar areas. Finally the Dreyfus five model of skill development is used as a basis for classifying the level of expertise shown by those involved in ISAD.

Chapter 4 outlines the research methodology. It begins with the philosophical position taken and explains why qualitative content analysis was the most appropriate research method for this type of research. The capstone project environment and the manner in which supervisors and students interacted are discussed. The backgrounds of the students involved and the professional analysts who supervised them are described. The particular instruments used to gather data are explained and how they were applied. The procedure for analysing student journals and analyst interviews are explained.

Chapter 5 provides an analysis and summary of the interviews of the professional expert analysts who supervised the students involved in this research. It is structured as a number of logically grouped categories of interest including issues related to students understanding and issues relevant to the supervisors themselves.

Chapter 6 provides an analysis and summary of the students' journals. Because of the quantity of material involved, the chapter provides a summary of the concepts most mentioned and provides few students' comments. The more detailed analysis illustrated by students' further comments is provided in Appendix C.

Chapter 7 brings together and discusses the results from the analyses of student journals and expert supervisor interviews. This chapter highlights the key issues which were perceived by students from the perspectives of both students and supervisors. As these issues are considered and discussed recommendations are made as to how these issues could be addressed.

Chapter 8 concludes this thesis. It reviews what has been accomplished and its limitations. It describes its contributions to research, teaching and professional practice and then recommends areas for further research.

# 2 JUDGMENT

## 2.1 Introduction

In this chapter the more popular understandings of the term judgment are explored followed by a brief discussion of the importance of judgment in thought. Thereafter the difference between classical rationality and judgment is discussed. The idea of "knowledge of particulars" provides a way of looking at knowledge which is not based on working from universal principles as required by classical rationality. This knowledge of particulars provides a way to understanding tacit knowledge or "know how" that is otherwise dismissed or left unexplained. The holistic aspects of judgment are described and viewing complex judgments as the final product of a complex structure of intermediate judgments suggests how judgment can be improved as a part of learning. A range of different types of judgments are reviewed. Judgment is acquired through development of expertise and some pertinent aspects of expertise are described. Finally, metacognition which is an essential component for the development of expertise, is then discussed.

## 2.2 What is judgment?

There are many possible meanings to the term judgment. One meaning is as a decision or opinion. The description from Lipman (2003, p. 23) of judgments as "*settlements or determinations of what was previously unsettled, indeterminate, or in some way or other problematic*" sums this idea quite well. Some judgments can be arrived at relatively quickly as, for example, when we compare two objects and we are able to determine almost immediately that they similar or dissimilar in some way. These are, at least partially, judgments of perception. At the other end of the scale some judgments involve considerable time and effort in gathering, examination and consideration of evidence before a decision can be made. An example of the latter is a judgment by a magistrate at the end of a complex legal case.

Another meaning of the term is as the ability to reach an intelligent conclusion especially with the implication that it is tempered by experience, training and maturity.[1] We might, for example, describe someone as having good judgment in financial matters because of their knowledge, experience and previous history of making sound decisions. However, the same individual may display “poor judgment” when it comes to other matters such as relationships with other people and find themselves in situations that they themselves or others might view as unfortunate  because of their poor decisions (Goleman, 1995). Implied in this definition is that judgments are about affecting, or having the potential to affect, the world or the course of events in some way. Also implied is subjectivity because these types of decisions have of notions of better or worse, more or less appropriate and so on. A Constructivist view of the world suggests that these decisions may not be able to be differentiated on the basis of “rightness or wrongness” but as human beings we can differentiate them on the subjective basis of effectiveness towards ends of our choosing. In the first example above this might relate to the acquisition of wealth or in the second example involvement in happy and satisfying relationships.

Making a judgment is associated with a process which leads to an opinion or decision. Someone going to a court of law will undergo some established legal process which leads to a legal judgment. Various tests, examinations, evaluations and so on can be called judgments and the validity of the final judgment is closely linked to the processes that lead to the decision. If I was undergoing an examination which occurred over a period of time but the examination was cancelled partway through it is quite legitimate to say that I was being judged but the judgment had to be cancelled.

What we hope to develop is the ability called judgment in those we educate. It is hoped that through appropriate instruction the judgments made by those being taught will develop to become more soundly based or better in some measurable way based on the

1 http://www.merriam-webster.com/dictionary/judgment

evaluation of those deemed to have a reasonable level of expertise in the relevant matter. From an educational standpoint it is often not the particular judgments made by students that are of major interest but rather the nature and quality of the processes that lead to the judgments (Hogarth, 2001). We make the assumption that if a student learns to develop "better" processes in order to make judgments then the judgments themselves should also be "better" (Einhorn & Hogarth, 1981; Mellers, 1998).

So, what is meant by "better", "more soundly based" and "higher quality"? Whether someone's judgment in a matter is "intelligent" or "good" or "bad" and so on depends on the values or criteria used to measure the quality of the judgment (Schroeder, 2008). Criteria for success are established (either explicitly or implicitly) and the result of a judgment is measured against those criteria. Who sets these values or criteria for deciding upon whether judgments are good, bad or indifferent? In the end they are socially constructed and decided upon by various communities of people which have different status and respect within society as a whole and which may differ in their evaluations between themselves because they apply different criteria and value judgments. Examples of this might be in terms of legal judgments e.g. (Kiefel 2012; Kirby, 1990), in design e.g. (Mills, 2013) or qualitative research e.g. (Lincoln, 1995). Measuring a judgment against these criteria is far more ephemeral than counting how much money an investor made but powerful none the less.[2]

Within a community these evaluations may change with time as the values and criteria change over time. From a teaching perspective, the aim is to tap into what would be regarded as those communities commonly regarded as those respected within the field, in this case information systems and in particular ISAD, to determine what are regarded as the criteria and values highly regarded by those communities.

Judgment and its development would appear to have great importance and, in many practical areas it does, but it is often given little or no prominence in more academic communities. Why is this the case?

### 2.2.1 The importance of judgment in thought

Hager (2000), in examining the role of judgment in the workplace, asks the question as to why the notion of judgment has not been widely recognised and is often just ignored. He suggests that it is the influence on educational thought dating back to the time of

[2] The ideas in the introduction here derive from the insightful work by Lipman (2003).

Aristotle which shaped the dichotomies of academic versus vocational; theory versus practice; and rationality versus emotions and values. According to Hager "*for much of the history of philosophy, judgments have been equated with propositions*". The problem has been that judgments were seen as outcomes with an intellectual focus with these outcomes viewed as true or false propositions. However, practical judgments are more obviously about what to do and because they involve such things as emotions, values and intuitions Hager suggests that they have been seen as the province of psychologists rather than scientists and philosophers.

Judgments are often made unconsciously. They are so ingrained in our thinking that we are not even aware of them in much the same way as we are aware of breathing only when it is different to normal (as when climbing stairs or running) or someone asks us to think about it. When Schon (1983) describes how experts work in practice he describes how the expert displays his judgment through deciding on the problem to be solved, how to frame the problem, deciding on the rules to follow, deciding on what is important and so on. Often, these types of judgments are so automatic the person involved will not be aware of them. It takes something extraordinary such as a situation which defies standard solutions or when the person is asked to explain how some decision was reached that these judgments may be brought out into the light. According to d'Entreves (2006), the philosopher Arendt suggests that crisis in judgment goes hand in hand with a crisis in understanding. "*The crisis in understanding is therefore coeval with a crisis in judgment, insofar as understanding for Arendt is "so closely related to and interrelated with judging that one must describe both as the subsumption of something particular under a universal rule*". *Once these rules have lost their validity we are no longer able to understand and to judge the particulars, that is, we are no longer able to subsume them under our accepted categories*" i.e. when we perceive that we no longer understand what is happening we are forced to question the rules by which we have operated. Later, "*Arendt, however, does not believe that the loss of these categories has brought our capacity to judge, on the contrary, since human beings are able to fashion new categories and to formulate new standards of judgment for the events that have come to pass and for those that may emerge in the future*" i.e. when previous standards and rules fail to guide us judgment takes over.

The following section looks at classical rationality and judgment and discusses how they are different.

### 2.2.2 Classical rationality and judgment

It is interesting to note that the popular or common definitions of rationality are based around the notions of reasonableness, showing good sense, sanity and displaying sound judgment. Being rational and showing good judgment is somewhat interchangeable in everyday speech. However, when one moves into some academic areas particularly within the "harder" (typically physical) sciences, mathematics and philosophy, rationality has much narrower and stricter definitions. These stricter definitions have been referred to as "classical" or "technical" rationality. Walczak (1998) provides a concise summary of the features that constitute various versions of classical rationality. It is worthwhile discussing these notions of rationality because adherents to this view tend to dismiss judgment as at best of marginal importance if not outright either subjective or simply irrational (Healy, 1993).

H. I. Brown (1988), according to reviews by Simpson (1992) and Healy (1993), describes a classical of model of rationality. In this essay, Brown considers scientific reasoning and states that the supposed underlying model of what constitutes rationality is based on the premise of "*universal rules leading all competent adequately informed thinkers to the same conclusions*" (Simpson, 1992). A major criticism in Brown's argument against classical rationality is that when rules fail or conflict to guide thinking one must resort to meta rules and then when they fail or conflict "meta meta" rules must be appealed to and so on to higher and higher levels. Eventually one eventually runs out of levels and it not possible to proceed. Brown argues that judgment is what must be appealed to when the rules fail. Brown describes judgment as "*the ability to assess a situation, assess evidence, and come to a reasonable decision without following rules.*" (H. I. Brown, 1988) At first glance this might seem to suggest that appealing to judgment is an unusual event. As examples, Brown suggests that judgment must be used in cases in which one is attempting to develop new rules such as when writing a new computer program; cases in which we have to choose between a number of competing rules such as when constructing a proof in logic; and cases in which familiar rules fail us such as when scientific revolutions take place. All these require something beyond rule application. As further evidence of the limitations of classical rationality, Brown refers to the work of Kuhn and others who demonstrate that scientific reasoning resists analysis in terms of a rule governed approach.

Brown argues that classical rationality does not address issues such as determining the appropriate goal at which to aim; the appropriate starting point for applying rules; the appropriate rules to apply and knowing how to apply the rules. He argues that this is where there is a missing element to this picture of rational inquiry and this is the ability called judgment. Brown's argument brings judgment firmly into the picture of the process of inquiry but Brown placed judgment in a support role to the classical notion of rationality. Here, Healy (1993) suggests that Brown has not gone far enough and that Brown's arguments are strong enough to make the far stronger claim that judgment is central to inquiry and not just ancillary. Of course, Brown admits that judgments can be wrong so Brown argues that to have validity one needs to demonstrate "good" judgment. He suggests that this is developed through expertise. A simple and general definition of what is meant by the term "expertise" is provided by Ericsson (2002) "*consistent superior achievement in the core activities of a domain*".

At this point, we turn our attention to the work of Schon (1983) who discusses the design process in professional practice in a variety of professional fields such as architecture, law and psychology amongst others. Schon (1983) begins by arguing that professional fields are dominated by what he calls "*technical rationality*" which is similar concept to Brown's classical rationality and which comes under Walczak (1998) definition of classical rationality. According to Schon, technical rationality is based on the idea that "*professional practice consists in instrumental problem solving made rigorous by the application of scientific theory and technique.*" Again, the essence of this view of rationality is the idea that there are universal principles and rules that must be followed and that given the same situation any competent persons would arrive at the same conclusions. According to Schon, the underlying philosophy of technical rationality is based on a positivist paradigm. In a particularly extreme form of positivism, the Vienna Circle in the early 1900s expressed their epistemology that there were only two types of propositions "*either the analytic and essentially tautological propositions of logic and mathematics, or the empirical propositions which expressed knowledge of the world.*" Any other propositions were nonsense or irrelevant (Schon, 1983). Rationality required arguments to be completely objective[3] and follow principles, theory and rules. This idea as to what constitutes valid knowledge is very limited and is very limiting in terms of the processes available for discovering new knowledge. The major point Schon makes against technical rationality is that it is irrelevant to solving many problems in real world settings.

[3] i.e. free of personal emotions, instincts or cultural norms or moral codes

According to Schon (1983, p. 16) "*situations of practice are characterized by unique events*" and that "*practitioners are frequently embroiled in conflicts of values, goals, purposes and interests.*" Practical problems in the real world are characterised by complexity, instability and uncertainty. Schon (1983) and H. I. Brown (1988) agree closely on the deficiencies of stricter notions of rationality. Schon says as technical rationality is supposed to be applied "*we ignore problem setting, the process by which we define the decision to be made, the ends to be achieved, the means which may be chosen.*" Schon (1983, p. 40) and these are the very points made by Brown about scientific reasoning. Further, Schon goes on to make the point that in real world practice "*problems do not present themselves to the practitioner as givens. They must be constructed from the materials of problematic situations which are puzzling, troubling, and uncertain.*"

Just as H. I. Brown (1988) mentioned that good judgment is gained through the development of expertise, similarly Schon discusses the artfulness or skilfulness in making decisions of the practitioner who is an expert in their chosen field. He contrasts this with the novice who struggles to see what is important in the complexity of the situation, who struggles to frame a problem in a way that might be solvable or cannot foresee the possible consequences of choices made. A key difference between Brown and Schon here that can be highlighted is that while Brown saw judgment and hence expertise as ancillary to strict rationality, for Schon expertise is central to inquiry and decision making and that the technical principles, rules, methods and standards become the tools of the expert to use as required.

### 2.2.3 On reasons, insight and attention

Luntley (2005) provides a useful insight into the concept of judgment by contrasting how one rationalises behaviour. We use the term rationalize here to mean that behaviour is consistent with or based on reason. According to Luntley, when a person has theoretical knowledge of something classical rationality would suggest that the person should be able to adopt a top down approach by applying principles to a particular situation. However, from an educational perspective it is a well-known phenomenon that while a student has learned the theory and can do set exercises they typically have little or no idea how to apply it in practice. The student has concepts and rules but this knowledge is useless until the student gains insight into the environment into which it is to be applied. The student learns to put theoretical knowledge into practice; one learns to apply theoretical knowledge by developing the appropriate attentional skills. Attentional skills relate to knowing what to pay attention to in the environment, being able to discern it and then ignoring the rest of the environmental “noise”. Insight, virtually by definition, cannot be taught except by immersing someone in the environment to which some theoretical ideas can be applied and then inviting them to learn what the theory actually means. Similarly, according to Healy (1993), Kuhn argued that for science to progress, emerging scientists needed to understand the basic vocabulary of science, have repeated exposure to scientific problems and typical solution strategies and through this to acquire a “*way of seeing*”. This goes beyond pure rule determined activity and into what has been described here as an ability to make better judgments through the acquisition of expertise. As Kuhn implies, this ability is not necessarily something that can be explicitly written down.

Another way of rationalising behaviour is through appealing to knowledge of particulars. In this approach one gains experience of the environment, observes patterns or structure within that environment (i.e. meaning) and on the basis of those patterns and structures makes judgments and acts accordingly. There is no appeal here to theoretical knowledge or principles but rather to understanding or “insight” (the term used by Luntley) into that environment. In Luntley’s view, insight not only causally creates behaviour but it also provides the cognitive standards by which to justify the behaviour. Luntley draws, in part, from two related ideas: particularism (from ethical theory (Dancy, 2004)) and bounded rationality (from psychology (Gigerenzer & Goldstein, 1996)).

As a simple example illustrating Luntley’s ideas consider two children throwing a ball to each other. Neither one has a theoretical knowledge of Newtonian mechanics and projectile motion yet somehow through experience they understand enough about the behaviour of the ball in flight to be able to throw and catch the ball. Why does it work? The answer is in the bounded nature of the environment that they are in and that they are so immersed in it that have insight into what works and what doesn’t work in that environment.

Luntley’s ideas about knowledge of particulars and being able to operate in a rational way within a particular environment provide a useful bridge to workplace or practical knowledge. Practical knowledge has been distinguished from theoretical knowledge by the idea that it is about knowing how to do something rather than something that can be learned from a book. The mind through perception of the environment begins to interact with the environment, "*hooks in*" thereby developing an understanding of that environment. The mind finds appropriate "*fast and frugal*" heuristics and then the individual interacts with the environment to achieve his or her purposes without necessarily having done so on the basis of application of any theoretical knowledge. This purposeful interaction or interplay with the environment does not occur through the development of concepts like the scientist conducting experiments in the environment, developing theories and then applying them. This is what is sometimes referred to as tacit knowledge – the "*knowing how*" rather than the "*knowing that*". Sometimes the term tacit knowledge is used. However, Hager (2000), in reviewing practical or tacit knowledge through the works of well-known authors such as Ryle (2009), Oakeshott (1967)and Noel (1999), concludes that the terms practical or tacit knowledge are very ambiguous and not very enlightening. Some authors go so far as to suggest that tacit knowledge is unknowable and not teachable.

### 2.2.4 Drawing from psychological research

Recently within psychology there has been a growing body of evidence supporting the idea of tacit knowledge and implicit learning and that it is an effective way of making appropriate judgments in certain environments (Dane & Pratt, 2007; A. S. Reber, 1989; Arthur S. Reber, 1992; Seger, 1994; Stadler & Frensch, 1998). Implicit learning is the concept of learning in an environment in a non-conscious manner and which can lead to the development of complex, domain-specific understanding of the environment i.e. knowledge about the structures and patterns underlying that complex environment. In practice, implicit learning leads to perceptions of knowing without conscious attention i.e. one perceives a particular situation and "knows" what to do next (Hogarth, 2001). While the process by which judgments are made is not consciously accessible, when one has acquired knowledge through implicit learning, the results of this knowledge are consciously available i.e. the judgments themselves. In fact, psychologists have more recently argued for a dual processing approach to information processing in humans which combines both conscious processing as espoused in classical or technical rationality and unconscious processing which leads to perceptions of knowing and is described as implicit or tacit knowing. Dane and Pratt (2007) provide an excellent and detailed review of the literature in this area.

Dane and Pratt (2007) review and synthesize the literature from management and psychology relating to nonconscious learning and decision making. He states that recent literature in psychology supports the notion of two distinct information processing systems operating in human beings. One is an intuitive and unconscious system "*which permits individuals to learn from experience and reach perceptions of knowing without conscious attention*" while the other is the conscious and rational system which "*enables individuals to learn information deliberately, to develop ideas, and to engage in analyses in an attentive manner*". Dane and Pratt (2007) suggest that the literature converges on four characteristics involved in intuition which are that

1. It is non-conscious process capable of processing complex information which results in consciously accessible intuitive judgment but how the judgment is arrived at is not.
2. It is a process in which "environmental stimuli are matched with some deeply held (nonconscious) category, pattern, or feature" and is capable of holistic associations. These categories, patterns or features could have been learned intuitively or explicitly through practice but are accessed without conscious effort.
3. It is rapid (e.g. classic cases are chess masters, firemen and surgeons who need only seconds to determine the state of a situation and decide the next action). Dane contrasts intuition with what he terms "insight" which he describes as sudden understanding of a situation often occurring after a long incubation period but in which the associations that lead to the understanding are consciously available.
4. Intuitive judgments are often affectively charged and may be associated with "feelings" of rightness or correctness (e.g. people may mention having "gut feel" or a "feeling in their bones")

Embodied cognition (Clark, 1997; Lakoff & Johnson, 1980; Varela, Thompson, & Rosch, 1991) is a psychological position that emphasizes the role of the body in shaping the mind. This suggests that our ideas, thoughts, concepts, categories and so are shaped by things such our perceptual system, the way our body and brain are constructed and operate. Piaget's work with the development of children(Piaget, Cook, & Norton, 1952), for example, demonstrates that are humans have very basic, genetically transferred understandings and ways of operating in the world which are built in and which are triggered at appropriate times in an appropriate order. Embodied cognition is an alternative approach to other theories of cognition but does suggest how humans communicate and interact. It is our sameness at the most fundamental levels of perception, interpretation and processing that allows us to interact and share at a personal and cultural level.

Bounded rationality proposed by Simon (1955) is "*a prominent theory influencing many domains of research including economics, political science, psychology, and artificial intelligence*" (Hanoch, 2002). Simon proposed the idea of bounded rationality as a more realistic description of the way people reason compared to the prevailing assumptions of the day which included the idea that people are (or should aim to be) calculating machines applying theories and applying rules in an unemotional way to achieve predetermined goals. These included that people would be able to consider all the options, determine some probability for each outcome and then arrive at some optimal if not perfectly correct solution to problems. If emotions entered into the reasoning they were regarded as irrational factors and therefore to be avoided. Simon believed these to be extreme and unrealistic notions of human reasoning and one can see themes from more classical notions of rationality in this description.

Simon, in contrast to ideas prevalent at the time, suggested that people had limited ability to process information and selective memory and perception. They simply could not act in this detached, computer-like fashion as some depicted. Instead of seeing people as highly flawed in their ability to reason, however, bounded rationality suggested that the mind finds "fast and frugal" heuristics (similar to Dane's use of the term "intuition") that cheaply produce complex behaviour without requiring normative theories that show rational behaviour. Gigerenzer ( 2008) argues that many real world problems are computationally intractable and that "*no machine or mind can find the best (optimal) strategy, even if one exists*". Luntley suggests the person who uses "fast and frugal" heuristics may well be able to articulate good and sufficient reasons for their behaviour and decisions other than by the notion of following classical rationality.

Dane and Pratt (2007) are concerned with the usefulness of intuition in managerial decision making. To be useful, intuition must lead to what they describes as "effective" judgments. Here "effective" is assumed to have the standard dictionary meaning of "*producing a decided, decisive, or desired effect*" (Merriam Webster dictionary). Dane and Pratt suggest that intuition becomes more effective relative to more rational approaches as the environment becomes increasingly unstructured and ill defined. For example intuition can lead to highly inaccurate solutions when dealing with highly structured problems such as with mathematics and probability but as mentioned earlier many real world problems cannot be solved satisfactorily with the resources available, if at all, using purely rational approaches.

With regard to professional practice, Schon (1983) rejects strict technical rationality and its assumptions and proposes an alternative epistemology centred on the "*reflective practitioner"* who exhibits "*knowing in action*" which is underpinned by "*reflecting in action*". This reflecting involves "*practitioners in 'noticing', 'seeing' or 'feeling' features of their actions and learning from this by consciously or unconsciously altering their practice for the better*". When Schon describes the artfulness or skilfulness of the practitioner and suggests that this artfulness or skilfulness can only be learned by doing realistic tasks in realistic settings, it can be argued that what is being learned is not only further explicit knowledge and skills which had not been acquired by prescriptive teaching in artificial settings. It also may include the heuristics, rules of thumb and strategies that allow one to find good solutions in a reasonable time but it is also about acquiring the much broader holistic knowledge and skills that allows the practitioner to achieve his or her purposes. Schon discusses how the practitioner has their theories-in-use that they actually use as opposed to their espoused theories. How does one reconcile this? Is the practitioner lying? Perhaps in some cases but Schon is suggesting that this is universal. It is known from studies on experts that they often don't appreciate the complexity of their thinking. A way to reconcile this apparent mismatch about what that the expert practitioner does as compared to what they say is that that they are not operating at some conscious cognitive level but rather using intuition so that where the practitioner interacts with the environment at some unconscious level and not consciously theorizing or conceptualizing in order to do so.

Schon's view of reflection has great importance from the perspective of professional judgment. Practitioners in professional fields such as law, medicine, engineering and information systems and so on make judgments that effect change in the real world. However, these professional judgments typically have to be communicated and well-defended and this must be done through the use of language. What Schon provides is a strategy or approach which recognises the often unconscious manner in which practitioners operate and encourages the practitioner to put into language (i.e. consciously try to conceptualize) what the he or she may have learned and is using tacitly. By reflecting on and conceptualizing this understanding it then becomes communicable to and hence shareable with others. The same notion also applies when teaching or learning takes place in professional fields. The learner and teacher are expected to provide explanations for their judgments and thereby communicate their ideas and understandings and hence learn and develop.

In the following section the various aspects that are involved in making practical judgments are considered. This is then followed by the types of judgments that are routinely made illustrated with simple examples drawn from the IS field to illustrate their application.

### 2.2.5 Aspects of judgment

Hager (2000) suggests ten aspects involved in judgment. The first four aspects of practical judgment relate to its holistic nature:

1. "*Practical judgment takes account of the specific combination of features that characterise the specific environment in which the judgment is made.*"
2. "*Practical judgment is influenced by social and political norms and values prevalent in the environment that shape perceptions of and responses to workplace situations.*"
3. "*Practical judgment integrates the personal characteristics that shape humans' responses to workplace situations.*" As Hager (2000, p. 291) states, these involve recognition and integration of the cognitive, practical, ethical, moral, attitudinal, emotional and volitional aspects of human characteristics including that of the judger.
4. "*Practical judgment takes account of the changeability over time of the environment in which the judgment is made.*" Environments, particularly those in professional and workplace settings change, sometimes rapidly, over time. Judgments are made on the basis of the circumstances occurring at a particular time but may also take into account the history of that environment and possible futures events that may take place as best as they can be foreseen.

Practical judgment is aimed at changing the world. These judgments can be those very commonplace judgments people make daily throughout their lives which influence only a few people in small ways through to those cataclysmic judgments made by a few individuals such as politicians in which the lives of literally millions may be dramatically affected.

Significant practical judgments often involve a nest of intermediate judgments prior to the final or culminating judgments (Lipman, 2003). A doctor's diagnosis, and judge's verdict and an architect's design are all examples of culminating judgments. There will have been many intermediate judgments made before the final judgment was made. These intermediate judgments are not some random collection, however. These intermediate judgments are formed into an argument or chain of reasoning which eventually leads to the culminating judgment. A failure of any single intermediate judgment or in the chain of reasoning connecting those judgments may invalidate the culminating judgment. Significant practical judgments are "fragile" in the sense that because of the complexity of the environment and potentially changing circumstances, these culminating judgments are defeasible i.e. arrival of new knowledge or change of circumstances may invalidate or modify the culminating judgment.

The final aspect of judgment and in some ways the most important is provided by Cervero (1992, p. 93) who suggests that practical judgment is as much about determining what problem needs to be solved as the actual solution. However, according to Hager (2000), determination of the problem to be solved is often ignored in accounts of practical judgment. As mentioned earlier, Schon points out that in real life situations ready-made problems do not simply present themselves to the practitioner and H. I. Brown (1988) describes that judgment is involved in determining the appropriate goal at which to aim. This involves creativity and relates to Arendt's statement that judgment comes into play when understanding fails and that requires a re-evaluation of the situation.

### 2.2.6 Types of judgment

Lipman (2003) discusses judgments as being based on principle or practice, "*Principled judgments are those guided by standards, criteria, and reasons.*" One has to understand the principles by which these types of judgments are regulated. "*Judgments of practice … are the products of experience*" and these are developed through gaining experience. In professional and technological fields (such as IS) judgments are made on the basis of a mixture of the both principle and experience.

Lipman suggests that there are many types of judgments and that for teaching and learning they can be grouped into three orders: generic judgments, mediating and culminating judgments. Generic judgments relate to similarity and difference. Mediating judgments relate to analogical judgments, hypothetical judgments and so on.

Culminating judgments are generally associated with professional judgments which encompass areas such as social judgments, aesthetic judgments and technological judgments and so on.

Making culminating judgments can be improved not only by practising making culminating judgments but also by practising making generic and mediating judgments. Generic judgments make it "*possible to connect and relate or to distinguish and differentiate, and these make it possible for us to generalize and differentiate*" (Lipman, 2003). Lipman provides a long list of types of judgments grouped into the categories of generic, mediating and culminating some of which are mentioned below (Lipman, 2003, pp. 281-289).

In the order of *generic judgments* examples are judgments of identity, difference and similarity.

In the order of *mediating or procedural judgments* a few examples are judgments of inference, relevance, appropriateness, value, accepted practice, facts (as evidence). Many of these relate to critical thinking skills.

Focal or culminating judgments "*are performed when applied to a specific situation. This is where expertise or professional judgment comes in*". Lipman goes on to discuss how emotions can be most helpful in providing guidance, emphasis, or perspective, how context is important, reasons are sifted and screened, alternative arguments are made and judged to see which are more persuasive and so on.

Lipman's ideas provide a way of improving professional judgment provides a means of both clearly identifying a judgment, what type of judgment it is and the criteria by which it might be justified. Alternatively, opportunities can be provided to identify and practise particular types of judgments which are appropriate.

### 2.2.7 Judgment Summary

In this section, the concept of judgment was examined. Judgment is both a decision about something previously unsettled and also an ability to reach intelligent conclusions.

Classical rationality is concerned with solving problems by the application of rules and correctness while judgment is concerned with determining goals to be achieved, which rules to apply and how to apply them. Making judgments involves emotions, values and intuitions which are not addressed by strict application of rules or technical correctness.

Situations of professional practice typically involve complex, ill-defined and unstable environments with conflicts of values, goals and interests. While professionals must use technical knowledge and rational thought it can only be done so using judgment which requires thinking holistically about the situation so that judgment takes into account human and social factors, changes over time and so on. These judgments are evaluated on the basis that they meet the needs of the particular situation rather than simply rational or technical correctness.

Even though humans are limited in their ability to process information in strictly explicit and rational ways they have the capacity to develop their ability to arrive at intelligent conclusions quickly through experience gained in working in practical situations even when problems appear technically intractable using purely rational means. Research suggests that this ability is possible because humans learn and have access to knowledge both in a conscious manner but also intuitively and that they combine both methods in evaluating situations and reaching conclusions.

Those recognized as experts in a field have abilities of evaluation and reaching conclusions far beyond others in their field. They think holistically and intuitively using rich cognitive frameworks developed specifically to their field which allows them to arrive at intelligent conclusions in a timely manner. Because of the intuitive nature of their thought processes however, experts are not necessarily able to articulate how they evaluate situations and arrive at their conclusions.

Understanding expertise and how expertise can be developed can facilitate the abilities of students hoping to join a profession or for those already in professional practice. The next section examines expertise and experts in a general way and this is then followed by focusing on expertise in information systems requirements analysis.

## 2.3 Expertise

### 2.3.1 Introduction

Practical or professional judgment can only be learned through the experience of real world problems. There are areas like the physical sciences, branches of mathematics and philosophy where one can feel very comfortable about the universality of the principles and laws simply through centuries of experience and that there appears to be nothing that might upset these principles and laws. However, as mentioned before, even in the application of these principles and laws, they are merely tools and it is humans who must apply and extend them as they see fit and this requires judgment.

In areas of practice and professional judgment the environment is so complex that available theoretical principles and laws are but a subset of the entire range of factors that must be taken into account. Not only might the “wrong” problem be solved, but strict application of theoretical principles may be completely unrealistic within the resources available if not impossible under any circumstances. Furthermore, the practitioner must take into account the particular problem context, social and political norms and values, personal characteristics and changing nature of the environment over time. Practitioners therefore need to develop and apply “fast and frugal” approaches to solving practical problems which lead to effective solutions. Again knowing which “fast and frugal” approaches to use and when they are appropriate in the circumstances is where judgment is needed. These can be considered the conscious approach to practical judgment.

Practical judgment is also intuitive. As mentioned earlier, human learning takes place unconsciously through experience and the learner develops cognitive schema which allow the person to evaluate situations in a rapid and unconscious manner and to make judgments intuitively. In professional fields there are often large bodies of explicit knowledge that the practitioner must be aware of and to apply appropriately. The professional practitioner merges the explicit knowledge of their field together with the intuitive knowledge that has been developed by practice in the field to arrive at effective judgments. These judgments in many cases must still be defendable although the justification would not rely on classical notions of proof of correctness but more on the basis of critical reasoning.

Given this situation, what type of experience is effective in improving practical judgment and under what type of conditions is this most likely to occur? In many fields of endeavour there are people designated as experts in that field. These individuals stand out from the amateurs, novices and even competent practitioners in that field by demonstrating greatly superior knowledge, experience and skills in the field by whatever are deemed to be the standards and values established by the community of practice in that field. This empirical measure is contrasted against those in a field who may have imposing credentials but who can sometimes demonstrate little or no better success than amateurs or other practitioners when their performance is evaluated (Ericsson, 2002).

Research suggests that domain experts possess highly sophisticated, intuitive cognitive frameworks that allow rapid but accurate responses to very demanding situations (Chase & Simon, 1973a; H. L. Dreyfus & Dreyfus, 1986; Klein, 1998, 2003; Prietula & Simon, 1989; Simon, 1987, 1992, 1996; Simon & Gilmartin, 1973). This stream of research has tended to either to view intuition as a useful complement to rational (conscious) thinking or to favour the use of intuition over more rational models. In critical situations (e.g. surgeons in life and death situations, firemen at the scene of fires, chess masters in competition) the intuitive cognitive framework allows fast and accurate judgments to be made. In less critical situations, both the explicit and intuitive frameworks may work together in making judgments (Dane & Pratt, 2007). It should be noted however that, to be effective, the cognitive frameworks which are developed must relate to the environment to which it is being applied and match the complexity of the environment (Weick, 1995).

### 2.3.2 Defining Expertise

Expertise is more than just general problem solving skills and it is more than memorizing or having access to a collection of facts relevant to a particular area. Anyone who has not had training in medical diagnosis and has tried to diagnose their own medical symptoms via the internet has probably become worried that they could be suffering from a host of possible diseases both rare and common. As the search continues the list often grows ever larger. Even the intelligent “amateur doctor” tends to be overwhelmed by the information available and struggles to relate it to the particular problem that needs to be solved. In contrast to this, a trip to a competent doctor often results in a correct diagnosis in a matter of minutes. Furthermore, the doctor will take into account any known current medical conditions you may have and medications you are taking to suggest an appropriate course of action.

Discipline areas differ in the way that they are organized and in the way they approach inquiry (Bransford et al., 2000, p. 155). According to Bransford et al. (2000, pp. 132-133) John Dewey identified two notions of knowledge. The first notion was a record of previous cultural accomplishments in the discipline. The second was as engagement in active processes indicating what needed to be done in the discipline. Bransford et al. (2000) provide several examples of active processes: doing mathematics involves solving problems, abstracting, inventing and proving; doing history involves constructing and evaluating historical documents; doing science involves testing theories through experiments and observation. To develop expertise in a discipline one needs to become familiar with its achievements as well as learning the skills of how you do it.

Expertise involves "*the development of pattern recognition skills that support the fluent identification of meaningful patterns of information plus knowledge of their implications for future outcomes*" (Bransford et al., 2000, pp. 57-59). This knowledge and skill is gained through the investment of time and effort and is found to be roughly proportional to the amount of material being learned (Singley, 1989). Even a talented individual still needs a great deal of practice to develop their expertise.

### 2.3.3 Developing Expertise

The development of expertise does not progress just through any sort of practice. It must be "effortful" or deliberate practice where the practice is tailored to the goal of improving performance (Ericsson, 2002; Ericsson, Krampe, & Tesch-Römer, 1993). No amount of playing the piano for fun will make you a concert pianist. Furthermore, the individual concerned must be motivated, open to new ideas and have the opportunities and challenges to keep on advancing their level of expertise (Ericsson, 2002). Practice or experience without these qualities will not advance expertise. Simon and Gilmartin (1973) suggested, with what was called the 10 year rule, that it takes at least ten years to become an expert in any field. This rule was drawn from the study of relatively small range of fields (e.g. music, sport and chess) and so the extent of its applicability in other fields is questionable. Even within these fields, recent research has found great variability around the average figure in the time to reach expert level and in many cases, despite many more than the 10,000 hours of practice, expertise is never reached. The conclusion drawn by some researchers is that deliberate practice is a necessary but not sufficient condition for developing expertise in a field and that other factors might predispose individuals to expertise in particular areas (Meinz & Hambrick, 2010). Plomin, Petrill, Plomin, and Petrill (1997) argue, for example, that there are biological or genetic factors which cause these superior abilities. On the other hand, Ericsson (Ericsson, 2002, 2004, 2006) suggests that these superior abilities are the just the result of previous practice and Alexander (1992) states that background knowledge is a greater determinant of how much you can learn about something than general learning ability.

In a meta-review of expertise literature, Hambrick et al. (2014) suggest that it is a combination of genetic and biological traits, deliberate practice and personality factors such as passion and persistence that were required to reach expertise. The evidence in this area is not definitive, but, what is clear from the evidence is that very high levels of skill can be developed by individuals whether they appear to have superior cognitive abilities or not (Gobet, 2005). Wai (2013) concludes from his longitudinal study of expertise, "*talent matters, but so does practice*" .

How one improves expertise and therefore professional practical judgment described above is through what Arendt (d'Entreves, 2006) described as crisis. While the term crisis is normally used to indicate something particularly dramatic (i.e. a point of extreme danger) here it is intended more in the sense of an unstable situation or turning point where understanding or skill is being challenged. This crisis might be imposed by the nature of professional practice as is described by Schon where there is "*complexity, uncertainty, instability, uniqueness, and value-conflict*" Schon (1983, p. 40). This poses what I will describe as "naturally occurring" crises. On the other hand crisis can be invoked by others through questioning or one's need to justify actions or judgments or it can be invoked by the practitioner (at whatever level of expertise they are at) pushing themselves through their own desire to improve their understanding and skills.

Whatever is the driver, expertise is developed by appropriate crises or challenges followed by reflection on understanding or performance and then, hopefully, followed by an improvement in the understanding or performance. When Schon describes the "reflective practitioner" he not only describes how an expert operates but more importantly a process or approach to practice by which expertise can be improved. Similarly, Argyris' Double Loop learning (Argyris, 1976, 1977) and Action Science by Argyris, Putnam, and Smith (1985) are also designed to challenge thinking and behaviour and then, by reflection, to improve practice.

Why is expertise relatively rare and so difficult to acquire? Ericsson (2002) suggests the answer to this question. First, individuals are hampered by beliefs about their own limitations as well as humans in general. After initial effort and improvement they reach a point where they believe little or no further progress is possible and so they stop trying. They then "plateau" at that level of expertise. Second, individuals typically need access to appropriate teaching, coaching or other resources to guide their development – effort on its own is not sufficient. Third, development of expertise requires the motivation to maintain deliberate and concentrated effort aimed at continual improvement. Any level of expertise becomes internalized and automated i.e. it becomes unconscious. Individuals must actively fight against this natural reaction to stagnate at a particular level and deliberately find ways to push themselves to higher levels. This is not easy.

It is useful to identify two typical but important examples of crisis which leads to development of expertise from Bransford et al. (2000, p. 179). Although both examples come from science, they are illustrative of the sorts of crisis that cut across all disciplines but have particular applicability to the professions. The first relates to the problem of learning new scientific concepts. Before people come to learn scientific concepts they have already constructed a view of the physical world dating back to very early childhood. This view can be very deeply held because this view has helped them to explain and predict the physical world and hence is very fundamental. However, if this view is in conflict with scientific concepts being taught then it may hinder learning.[4] Constructivist learning theory suggests that we learn new things by first associating them with what we already know, so this learning difficulty is no surprise. Developing expertise requires the assimilation of new concepts, mental models, views and probably also attitudes that will equip the learner for the type and level of expertise required.

The second example relates to skill. While one can be shown solutions to problems in physics, this does not give one insight on how to go about solving problems. In physics, experts describe the problem in detail before attempting a solution, determine the relevant information required for the solution to the problem and have the ability to decide the most appropriate procedures to generate problems descriptions and analyses. However, this is rarely taught explicitly in physics courses (Bransford et al., 2000, pp. 175-176). It is no surprise then that students exiting a physics course may know many facts about physics but not know how "to do" physics. In a similar fashion, one can read literature, have a good knowledge of what constitutes "good" writing but not know how to go about writing well. More broadly, this illustrates the notion that to reach higher levels of expertise one needs to either discover or be shown more effective ways of operating.

An area that has been extensively studied by cognitive psychologists in order to understand expertise is that of chess. Chess provides a useful field to study expertise

---

[4] The issue of developing appropriate metal models in information systems was dealt with earlier but is consistent with this example.

because it is intellectually complex but importantly because its competitive nature allows one to compare players on their demonstrated ability rather than by their reputation. Furthermore, players can be tracked and studied over time and their development as players analysed. Psychologist de Groot (1978) found that as chess players progressed from novice to expert level (which is below master level) players were able to analyse more possibilities for moves, but at master and grandmaster levels, however, choices are made from a better set of possibilities rather than more of them. More recent findings found that weaker players could spend large amounts of time analysing possible moves and miss the right move while the grandmaster is able to "see" the right moves almost immediately without conscious analysis. Moreover, grandmaster players had excellent recall of positions of pieces and moves in a game while novices' recall was poor. The expert's ability to make the right judgments almost immediately and to be able to recall relevant subject matter extensively has been found in other fields as well.

### 2.3.4 Theories Underpinning Expertise

One theory about how experts are able to do what they do is Chunking Theory (Chase & Simon, 1973b) which suggests that information is viewed and remembered as meaningful patterns called chunks. It is thought that chunking is needed by humans because short term memory can only deal with five to nine items at a time (Miller, 1956). The expert stores and recalls chunks in long term memory and manipulates chunks rather than individual items of data in short term memory. Simon estimated that grandmaster chess players could access 50,000 to 100,000 chunks. Chase and Simon's chunking theory, to a reasonable extent, was able to explain expertise in other areas such as arts, sports, science, and the professions (Richman, Gobet, Staszewski, & Simon, 1996). Fernand Gobel (Gobet, 1996, 1997) developed a rival theory suggesting that the mind uses templates which contain "slots" into which various concepts e.g. representing chess pieces, could be inserted. Rather than have to remember a multitude of independent patterns, the expert combines a large number of patterns as variations on a base template.

Schema theory (R. C. Anderson, 1977; Richard C.  Anderson, 1978; Richard C. Anderson & Pearson, 1984; McVee, Dunsmore, & Gavelek, 2005) suggests that access to information is made in long term memory by mentally following paths. The implication of schema theory is that new information that fits into a well-developed schema is far better retained than information that does not into the schema. “*One important insight of schema theory is that meaningful learning requires the active involvement of the learner, who has a host of prior experiences and knowledge to bring to understanding and incorporating new information … What you learn from any experience depends in large part on the schema you apply to the experience.*” (Slavin, 2006)

One needs to be careful in trying to extrapolate the findings of the research on expertise based on a single field or even a few fields. For example, the chess player is concerned with a very limited environment (the chess board and the pieces on it), precisely defined rules of play are and the chess player relies solely on their memory and analysis skills during play. In another field it is reasonable to suppose that different skills and approaches to knowledge apply. For example, in the field of history we could compare the novice with the expert historian in trying to understand an historical event. It is quite possible that the expert historian will actually take longer to come to their understanding than the novice. Novices tend to be more superficial in their analysis of the problem, are aware of fewer ways of gathering and evaluating information and tend to evaluate events on contemporary thinking rather than on norms of the time. The historian on the other hand appreciates the potential complexities of the event to be understood and realizes that one needs to be more methodical in researching and evaluating if a satisfactory understanding is to be reached. Similarly, the engineer, the business analyst, the writer and philosopher operate in environments which are dramatically different to fields like chess but are also very different to each other. These differences relate to the extent and state of the environments, the nature of the problem to be solved or even to be defined, the nature and extent of the rules or standards that exist, the creativity which can be employed, the criteria for success and so on. To highlight our lack of understanding, one specific point of difference between chess and fields like engineering, architecture, information systems and so on is the use of external representational models (e.g. diagrams, charts, simulations etc.) for the recording of information, for problem analysis and solution discovery. These offload the need to remember and evaluate everything in one’s head. In spite of the fact that these types of external representations have been in use extensively for centuries, the understanding of how these representations work is fragmentary and contains fallacies and assumptions (Scaife & Rogers, 1996). It appears that, although we can often identify those who are experts in different fields by their achievements, by and large how they do what they do so well and how they developed their expertise is poorly understood.

## 2.3.5 Transferability and Competence

A long established finding about expertise across different fields is that transferability is limited to the area of overlap (Thorndike & Woodworth, 1901). Gobet (2005) suggests that this lack of transferability may actually become worse at the highest levels of expertise since the acquired knowledge and skills are so highly specialized. Even within the game of chess, for example, a chess master's skill in remembering positions of pieces on a chess board applies only to configurations that might come up in genuine play and for other configurations they are no better than novices. More recently, this type of finding even extends to sports where athletes sometimes demonstrate abilities related to their area of expertise that scientists had hitherto thought to be physically impossible but at the same time these individuals often show no other greater general abilities than the average person (Ericsson, 2002).

Dreyfus and Dreyfus (1980) developed a model of skill development which categorized levels of competency into five stages; these were novice, competence, proficiency, expertise and mastery. Although their original work was in training pilots, the Dreyfus model has been successfully applied in other areas (e.g. language learning, nursing). Their model begins with the novice being shown *abstract features* which they can recognize without the benefit of experience and rules for determining actions on the basis of the given features. In the next stage called competence, the student is able to identify recurrent meaningful patterns, called *aspects*, in realistic settings either by student's noting it themselves or being shown. On the basis of these aspects, guidelines provide the principle for actions. Aspects in this stage are perceived as equally important. In the proficiency stage the learner is exposed to a wide variety of typical whole situations. Each situation has some long term goal to be achieved and in the achievement of the goal, some aspects become more relevant or taking greater priority. The same goal at two different times (presumably when circumstances have changed) are regarded as two different situations. Students attempt to solve problems by the application of memorized principles called *maxims*. In the expertise stage, the student has developed such a vast repertoire of experiences that actions are guided by intuition rather than application of analytical principles (rules, guidelines or maxims). Situations are acted upon appropriately in an unconscious manner.  In the mastery stage, the expert

is able to let all the mental energy used in monitoring their performance go into producing almost instantaneous responses to situations in periods of intense absorption. There are two important factors in the Dreyfus and Dreyfus account of the five stage model. The first is that the expert or master operates intuitively and not through analytical thought using principles; they interact with the environment. Dreyfus and Dreyfus emphasized the importance of real world experience as *essential* for the development in the model beyond the stage of competency. This is supported by other researchers (see for example (Ericsson, 2002)). The second factor is that of self-monitoring of performance. Up to and including the expert stage, the learner is self-monitoring their performance, presumably with a view to either improving performance or at least satisfying whatever are the relevant evaluation criteria that are appropriate. Only the master, and this only on certain occasions, abandons self-monitoring.
Ericsson and Lehmann (1996) found that experts' superior performance was mediated by deliberate preparation, planning, reasoning and evaluation. This was found across domains such as medicine, computer programming, sports and games. General features of expert learning across many fields include the need to set specific attainable goals, designing and monitoring of learning activities and striving toward genuine understanding rather memorization (Ericsson, 2002). This process is termed self-monitoring, self-regulation or metacognition. It is not just important for development of experts but is also an essential *part of* their superior knowledge and skills.

## 2.4 Metacognition

In this section, some of the literature on metacognition is reviewed. As already mentioned, it is an important aspect of developing expertise. From an educational standpoint, if high levels of expertise in a specific area are not transferable then in areas where the environment is very broad or potentially subject to substantial change over time (such as in the information systems area) it would seem prudent to develop appropriate general knowledge and skills applicable across a wide variety of areas. Developing learners' meta-cognitive skills on both counts appear to be an appropriate strategy.
An informal description of metacognition is that it is thinking about thinking. Metacognition comes into play when we detect a lack of understanding about something, or when we are required to explain our thinking or simply if we have a

genuine desire to reflect on our thought processes or to improve them. Flavell (Flavell, 1976, 1979) coined the term "metacognition" describing it as "*one's knowledge concerning one's own cognitive processes or anything related to them, e.g., the learning-relevant properties of information or data.*" Flavell concentrated on the knowledge aspects of metacognition, while on the other hand A. L. Brown (1978) emphasized the process aspects of metacognition which included planning, monitoring and revising one's thinking. The latter view is exemplified by Schon's description of reflective practice or Argyris' double loop learning which relate metacognition in action where a person actively reflects on their practice with a view to understanding or improving it.

Metacognition is a fuzzy concept. Paris and Winograd (1990) noted that researches, depending on their research orientation, have developed different methodologies and definitions. Some writers have avoided "*rigid or operational definitions*" and given prototypical examples of it instead. These examples indicate cognitive judgments about metacognition in which they assess their own knowledge, confidence and strategies. Others suggest that it is the conscious awareness of thinking. Researchers oriented towards the executive functions of metacognition tend to argue that it can be "unconscious, tacit and inaccessible". Qualitative researchers focus reports of cognitive self-appraisal derived from interviews, think-aloud protocols, and subjective reports. Researchers with a more science based orientation find the fuzzy definition difficult to work with because its vagueness and ambiguity make it difficult to isolate from "normal" cognition and hence difficult to measure.

Most researchers into metacognition have definitions that emphasize "*(a) knowledge about cognitive states and processes and (b) control or executive aspects of metacognition*" (Paris & Winograd, 1990). This definition "*captures two essential features of metacognition – self appraisal and self-management of cognition.*" According to Paris and Winograd, self-appraisal reflects "*judgments about one's own personal cognitive abilities, task factors that influence cognitive difficulty or cognitive strategies that may facilitate or impede performance.*" Self-management refers to orchestration of the cognitive aspects of problem solving e.g. ability to plan ahead, use a variety of strategies, monitoring and revising ongoing performance. These tactics lead to good trouble shooting and problem avoidance. Ridley, Schutz, Glanz, and Weinstein (1992) provide a detailed description of metacognitive knowledge. In terms of self-appraisal, they also include knowledge of how human beings learn as well understanding a one's own learning processes. In terms of strategy, they also include connecting new information to what one already knows and understanding the task goals.

Metacognition is embedded with cognitive development and is "*both a product of and producer of cognitive development*" (Paris & Winograd, 1990). Younger children, for example, have poor metacognitive skills and as a result are not easily able to assess their own understanding, appreciate task requirements or apply strategies to improve their understanding. This improves over time, however, through experience and practising rather than being innate. At the other end of development, experts demonstrate high levels of metacognitive skills (Ericsson, 2002, 2004).

It is tempting to think that one could just teach metacognition in isolation (e.g. as a subject in its own right) but this may not be an effective strategy since like other cognitive skills it must be given a context and practised (Paris & Winograd, 1990). Applying the Dreyfus model of expertise, without that direct experience of applying metacognitive knowledge the learner does not move beyond the novice level and metacognitive knowledge that is "learned" will remain as abstract facts. Moreover, when metacognitive strategies are taught they should be those most appropriate for the type of expertise being developed and provided at a time appropriate for the level of expertise at which the learner is operating. Ericsson and Kintsch (1995) go so far as to say that cognitive and metacognitive development are so intertwined and domain dependent that they may not be separable.

It is easy to think of metacognition as simply the application of knowledge and development of skills. An important additional factor in metacognition is the learner's beliefs (Paris & Winograd, 1990). These relate to the expectations students have with regard to thinking and learning. A well-known example of a metacognitive belief relates to reasons for success and failure. Those who have a history of success attribute their successes to ability and their failures to lack of effort while those who do not have a history of success attribute it to lack of ability. What one often observes superficially, however, is that those who are failing find it more appealing to appear to put in minimal effort or find excuses for their failure rather than have to admit to what they perceive as their lack of ability. Learners select challenging tasks and persevere with them when they believe they can accomplish the tasks with reasonable effort (Bandura, 1982; Schunk, 1984).

Paris and Winograd (1990) suggest four dimensions to metacognitive beliefs. *Agency* relates to beliefs about one's abilities as learners and one's cognitive capabilities. *Instrumentality* relates to beliefs about the usefulness of strategies toward achieving ends. *Control* relates to belief in one's power to control and direct one's own thinking and hence that one's actions are responsible for successful performance. *Purpose* relates to belief in the purpose of one's learning. Examples of inappropriate purpose might be to see a task as simply something to be accomplished to satisfy some authority figure or to regard learning largely as a competition to be won. In either case the amount of learning which takes place may be minimal.

An important issue with regard to metacognition relates to validity and reliability of verbal reports and awareness. Subjects' verbal reports are often inaccurate (Garner, 1987), but there is greater validity and reliability the sooner after a particular task is completed and if questions are well targeted toward particular aspects of thinking (Afflerbach & Johnston, 1984; Garner, 1988). It is suggested that these problems are even more pronounced with experts who may be unaware of the complexity of their thinking[5] and with novices who may be unable to explain their thinking[6]. One should also be aware that asking someone to explain their thinking in artificial situations (i.e. in a contrived experiment and not in the actual environment where that thinking would actually take place) may also lead to false information as has been demonstrated in some cases.[7]

In spite of the potential problems with fuzzy definitions and potential problems with validity and reliability of peoples' accounts of their own metacognition, it appears to be well accepted that learners can improve their learning by becoming aware of their own thinking. This idea is also consistent with constructivist accounts of learning. Improvement of metacognition can be achieved by providing learners with appropriate strategies and encouraging discussion of both the cognitive and metacognitive factors in thinking. On the other hand, it is also suggested that inappropriate teaching of

[5] One can speculate that this may be attributable to the lack of expertise in the expert's domain by the researcher. Vygotsky's (1978) theory of proximal development suggests that one gradually moves up in levels of expertise and the researcher is simply not in a position to really understand explanations given by someone who will have spent many years developing their understanding and skill.

[6] One can also speculate here that someone who is a teaching expert in a particular domain may well have a greater awareness of the typical problems novices have and may be able to elicit explanations by well targeted questions

[7] Dreyfus and Dreyfus (1980) cite examples of such cases

metacognition may have a detrimental effect on the learner's development of domain knowledge and skills e.g. if the metacognitive knowledge or skills presented are of marginal value or it is provided at times when the learner is not prepared to truly understand or apply it (Paris & Winograd, 1990).
As mentioned in the previous section, expertise in a particular domain is only transferable to another domain to the extent of the overlap between the two domains. Because of its general nature, however, metacognitive knowledge and skills may have the potential to be transferable across many domains or to be very useful within domains which have a wide span or change rapidly over time. This is a factor to consider when teaching metacognitive skills.

### 2.4.1 Chapter Summary

In this chapter, the concept of judgment and its development was examined. Judgment is both a decision about something previously unsettled and also an ability to reach intelligent conclusions. Judgment has not been accorded much importance in the academic literature in the past. This has been historically been because of the importance placed on abstract thought rather than practical problem solution and with the rise of science a positivist stance that put any proposition not based on direct measurable evidence into the category of nonsense or irrelevance.
Classical rationality is concerned with solving problems by the application of rules and correctness while judgment is concerned with determining goals to be achieved, which rules to apply and how to apply them. Making judgments involves emotions, values and intuitions which are not addressed by strict application of rules or technical correctness. Situations of professional practice typically involve complex, ill-defined and unstable environments with conflicts of values, goals and interests. While professionals must use technical knowledge and rational thought it can only be done so using judgment which requires thinking holistically about the situation so that judgment takes into account human and social factors, changes over time and so on. These judgments are evaluated on the basis that they meet the needs of the particular situation rather than simply rational or technical correctness.

Even though humans are limited in their ability to process information in strictly explicit and rational ways they have the capacity to develop their ability to arrive at intelligent conclusions quickly through experience gained in working in practical situations even when problems appear technically intractable using purely rational means. Research suggests that this ability is possible because humans learn and have access to knowledge both in a conscious manner and also intuitively and that they combine both methods in evaluating situations and reaching conclusions.

Professional practice involves explicit knowledge of the field and intuitive knowledge developed by practice in the field. By its nature judgment is fallible but can be improved by the development of expertise. Experts are those practicing in a field who demonstrate performance far superior to others in that field. .Expertise is not just facts and general problem solving skills but is highly specific to a field and requires well organized knowledge and skills corresponding to that particular field

Expertise is developed through deliberate effort aimed at constant improvement and typically this takes many years to acquire in a specific discipline. Research suggests that these experts have developed highly sophisticated cognitive frameworks which support meaningful pattern recognition and implications for future outcomes that allow for rapid but accurate responses to situations in the field. Expertise is transferrable to another area only to the extent to which there is overlap with the other area.

It is clear that developing expertise requires very significant amounts of deliberate practice although the amount of practice required to reach the level of expert in an area varies from individual to individual with some never reaching expert level. A point debated by researcher is the extent to which biological or genetic factors influence the development of expertise.

Developing expertise requires crises which challenge a person’s understanding or skills. Crises can arise naturally because of the field through complexity, uncertainty, instability, uniqueness or conflict, through being challenged by others, through self-reflection, or in extreme cases through some dramatic situation that makes accepted principles and rules inappropriate. However, expertise is not easy to acquire for various reasons such as limiting beliefs about what one’s capabilities, lack of access to appropriate coaching, mentors or other resources or reaching a point in time when the motivation to maintain further development wanes.

The Dreyfus model of expertise proposes five stages of development: novice, competence, proficiency, expertise and mastery. Students in a field begin at the first two levels in which they learn to recognise abstract features and the rules and principles to apply in various abstract situations.  In proficiency they are exposed to a variety of real, holistic situations in which they operate through analytical thought to apply rules and principles. With expertise and mastery, performance becomes intuitive.

Metacognition (self-monitoring) is an essential part of developing expertise and evolves with increasing expertise. It involves deliberate preparation, planning, reasoning and evaluation with a view to setting attainable goals, designing and monitoring learning activities and striving toward understanding rather than memorization. It involves understanding one’s own learning processes, and linking new information to what is already known. In the Dreyfus model, metacognition occurs at all levels to regulate and improve performance although at mastery level masters can apply all their mental energy solely in performance in periods of intense absorption. It is suggested that there are four dimensions to metacognition: agency which relates to beliefs about ones capabilities; instrumentality which relates to beliefs about the usefulness of strategies towards achieving ends; control which relates to one’s power to control and direct one’s own thinking and actions; and purpose which relates to belief in the purpose of one’s learning.

Understanding expertise and how expertise can be developed can facilitate the abilities of students hoping to join a profession or for those already in professional practice. The next chapter therefore focusses on an examination of the knowledge and skills required in information systems analysis and design and the processes involved in its professional practice. It then reviews the literature related to the differences between novices and experts which then provides some insight into the development of expertise in Information Systems Analysis and Design.

# 3 IS ANALYST EXPERTISE

In this chapter the terms Information Systems analysis expertise and IS analysis expert will be used. However, if one were to do a search on the Internet (e.g. the Merriam Webster dictionary, Wikipedia) or to read a textbook relating to information systems often with the words "systems analysis and design" in the title e.g. (Satzinger et al., 2012) (Kendall & Kendall, 2014) as to the meaning of these terms one would find a wide range of descriptions. The descriptions would range from someone working closely with the business managers and users and working on the business problem description and requirements (often called a business analyst) through to someone at the technical end writing or modifying software and implementing hardware (often called a computer Systems analyst or Systems analyst). On the one hand business analysts have their business analyst body of knowledge BABOK® (Brennan, 2009) which describes the knowledge and skills that they should have while computer systems analysts have often been programmers and there is a long history of past experience to draw from to describe the typical knowledge and skills that they should have. Topi, Valacich, Wright, Kaiser, Nunamaker Jr., et al. (2010) discuss the difference between the disciplines of Information Systems and Information Technology and suggest that they are "*disciplines that on one hand operate in the same space (focusing on organizational needs) but on the other hand address a very different set of questions*". The same could be said for the difference between business analysts and IS professionals i.e. that they operate in a similar space but the questions they address are also different. Topi, Valacich, Wright, Kaiser, Nunamaker Jr., et al. (2010), in describing and trying to differentiate the role of the Information Systems professionals suggest:

> *"Professionals in the [Information Systems] discipline are primarily concerned with the information that computer systems can provide to aid an enterprise in defining and achieving its goals, and the processes that an enterprise can implement or improve using information technology. … Information Systems focuses on the information aspects of information technology."*

IS professionals, however, cover a broad range of possible careers within the field. The IS analyst that is proposed in this thesis, in fact, is one possible career path within the IS field. Unlike some other professions this career path does not follow a clearly and precisely defined body of knowledge or long established history of experience.

The first task in this chapter is to scope a relevant body of knowledge and skills and the activities involved in IS analysis and then determine the features that distinctively differentiate the IS analyst from other professionals that operate in the same overall space. Thereafter the relevant literature on information systems expertise is reviewed. Finally, combining this with knowledge about expertise in general, the levels in knowledge and skill as one progresses from novice to expert in IS analysis are suggested and described.

## 3.1 Analysis activities and the analysis process

There are a host of methodologies or approaches in use related to IT systems development which reflects the broad range of problems and environments in which IT development takes place (Aragón, Escalona, Lang, & Hilera; Avison & Fitzgerald, 2003; Dinesh Batra & Satzinger, 2006; Fitzgerald, 1997; Lang & Fitzgerald, 2006; Marinelli & Laplante, 2008; Neill & Laplante, 2003). Lang and Fitzgerald (2006), for example, provide a number of categories of methodologies and approaches, all of which have significant followings in industry. These include traditional approaches such as SSADM, Yourdon JSP and SDLC/Waterfall; rapid or agile methods or approaches (e.g. RAD, eXtreme Programming); approaches based around the use of tools and development environments (e.g. PHP, Java, Flash, ASP, J2EE, InterDev); incremental or evolutionary methods and approaches (e.g. spiral model, RUP, Staged Delivery, Iterative design); HCI/Human Factors Engineering methods (e.g. user centred design, goal based requirements) and technique driven development (e.g. storyboarding, flowcharts, UML, prototyping). In fact, the largest single category mentioned by Lang and Fitzgerald (2006) is actually hybrid, customised, or proprietary in-house methodological approaches. This host of methodologies and approaches however, spans a range of activities (particularly in terms of detailed design and implementation) that are not in the scope of what is expected of students conducting analysis projects in Capstone units. Providing such a comprehensive list of methodological approaches does highlight however that analysis based activities are conducted within many types of methodologies used in IS project environments.

While there may be many different methodologies, the activities needing to be being performed by students undertaking the capstone project are very similar. What changes is the context in which they are performed, their order and their emphasis. Many of the analysis activities that are performed fall within the systems planning and systems analysis stages in commonly prescribed systems analysis and design textbooks (e.g. (Rosenblatt, 2013; Satzinger et al., 2012; Shelly & Rosenblatt, 2011; Whitten & Bentley, 2005)). These include activities such as understanding, establishing and defining the problem or opportunity within the organisational context; stakeholder identification; determination of system goals and system scope; investigation of the current situation and relevant issues; functional requirements and non-functional requirements (e.g. usability, privacy, security, performance etc.) gathering in its various forms (e.g. interviewing, questionnaires, document analysis, observation, analysis prototypes etc.) and requirements prioritization; requirements management and documentation; modelling (e.g. data, processes, object, use cases, organisational etc.); research and evaluation of alternative solutions; feasibility analysis (e.g. technical, financial, organisational, ethical) developing recommendations; consideration of how the organisation will be affected by any proposed solution; change management issues (e.g. moving from a current business process to the proposed new one, technical support, determining impact on stakeholders and dealing with their possible responses); and the reporting and presentation of findings. Support activities include project management, communication with stakeholders, and people management. Analysts may well be involved in other activities in other phases of development but the list above is intended to describe the more common activities involved with planning and analysis.

It is clear that requirements analysis is a key aspect of analysis. Inadequacies in requirements analysis such as incomplete or inaccurate requirements and constraints can lead to delays, escalating costs or even total project failure (Bostrom, 1989; Byrd, Cossick, & Zmud, 1992; Chakraborty et al., 2010; Davies, Green, Rosemann, & Gallo, 2004; Mathiassen, Saarinen, Tuunanen, & Rossi, 2007; Vessey & Conger, 1993; Watson & Frolick, 1993; Wetherbe, 1991). This is a difficult task. Schenk, Vitalari, and Davis (1998), for example, state, "*From a cognitive perspective, the analyst must identify important cues amid a sea of extraneous information, set goals, generate and test hypotheses concerning the system attributes, process dissimilar information from multiple sources, and distinguish between relevant and irrelevant information. He or she must then reformulate the problem into a common nomenclature for technical and nontechnical audiences and specify a consensus-based, error-free set of systems requirements*". There is considerable overlap between the activities of systems planning and analysis from the information systems field and requirements engineering from the software engineering field and a great deal can be learned from the requirements engineering research which is relevant to thinking about Information Systems analysis as a process.

A commonly cited definition of requirements engineering (RE) is that by Zave (1997), "*Requirements engineering is the branch of software engineering concerned with the real world goals for functions of and constraints on the software systems. It is also concerned with the relationship of these factors to precise specifications of software behavior and their evolution over time and across software families.*" More recently, the importance given to RE in software engineering practice has increased, for example, Aurum and Wohlin (2005) suggest that "*Requirements engineering has now moved from being the first phase in the software development lifecycle to a key activity that spans across the entire software development lifecycle in many organizations.*" With regard to the evolution of requirements engineering, Nuseibeh and Easterbrook (2000) state that three important ideas about the practice of RE emerged in the 1990s. Firstly, that "*modelling and analysis cannot be performed adequately in isolation from the organisational and social context in which any new system will have to operate.*" Secondly, the notion "*that RE should not focus on specifying the functionality of a new system, but instead should concentrate on modelling indicative and optative properties of the environment … Only by describing the environment, and expressing what the new system must achieve in that environment, we can capture the system's purpose, and reason about whether a given design will meet that purpose.*" And thirdly, the "*idea that the attempt to build consistent and complete requirements models is futile, and that RE has to take seriously the need to analyse and resolve conflicting requirements, to* *support stakeholder negotiation, and to reason with models that contain inconsistencies.*" These ideas have more closely aligned to the information systems perspective (i.e. that information systems development is essentially about solving business/organisational problems) but with the software engineering perspective. The major differences appear to be the greater involvement of IS analysts in the systems planning stage of business problem definition and feasibility analysis and in the later stages of the systems analysis where there is a broader perspective taken in searching for alternative solutions which satisfy the organisation's goals and the development of information technology is not the primary focus. Within the scope of the common activities relating to requirements elicitation, analysis, validation and documentation, the RE literature provides some useful insights about the process involved.

The academic literature on requirements engineering has proposed models of the activities involved in the requirements engineering process. One example (diagram reproduced from Martin, Aurum, Ross, and Paech (2002)) is the Kotonya and Sommerville model (Kotonya & Sommerville, 1998) which suggests a conceptual linear RE process model, with iterations between activities (see figure below) and activities in the model overlapping and often performed iteratively. The problem context, stakeholders and users are mostly implied in the process and there is an implication with the box described as System specification that software is the end product.

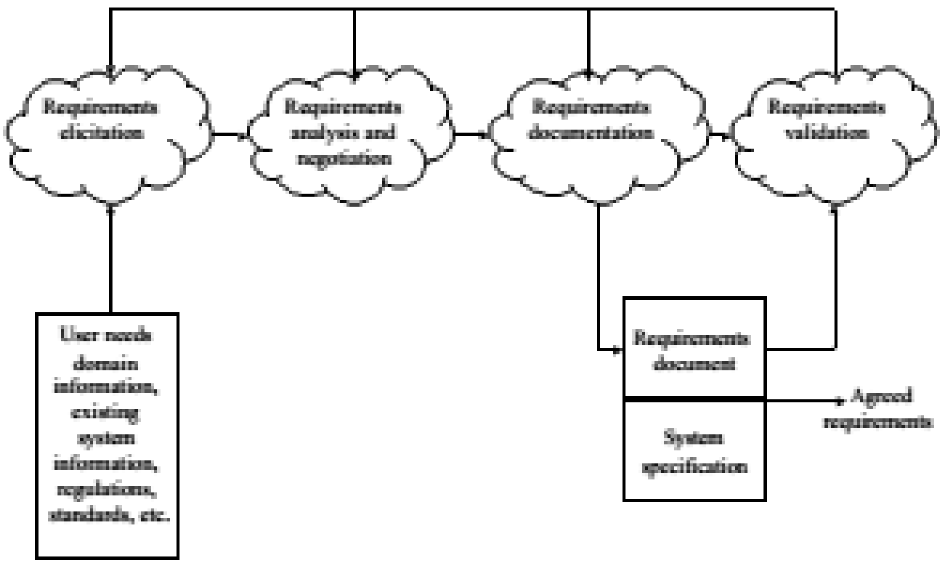


**Figure 1 Requirements engineering model from Kotonya and Sommerville (1998)**

Another example (diagram reproduced from Martin et al. (2002)) comes from Loucopoulos and Karakostas (1995) indicating an RE process which is iterative and cyclical in nature (see figure below). The involvement of stakeholders and the problem domain figure more prominently in this diagram.

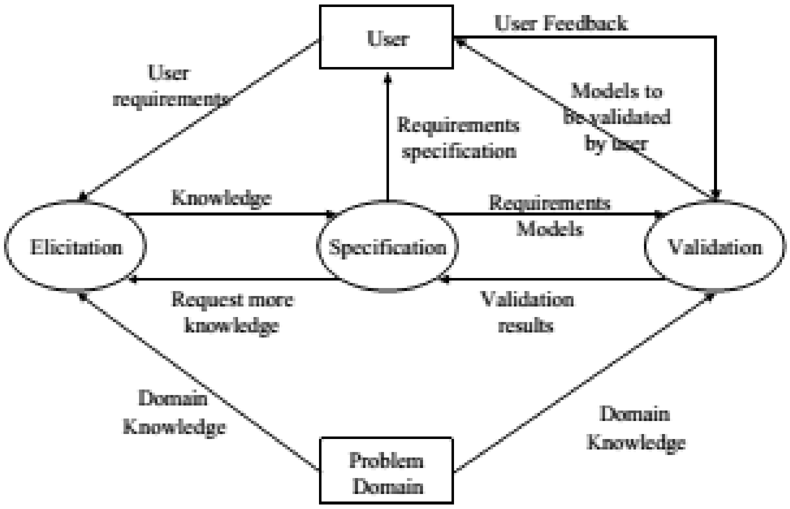


**Figure 2 Requirements engineering model from Loucopoulos and Karakostas (1995)**

The models above present a somewhat idealized picture of the process of requirements elicitation, analysis, validation and documentation. In practice, the process is typically not an orderly one. Nguyen, Armarego, and Swatman (2005) found, for example, that requirements engineering was not systematic and smooth but, instead, was an iterative process involving what they described as a catastrophe-cycle RE process and operated opportunistically. Houdek and Pohl (2000) in their RE case study stated that "*the activities, especially the elicitation and validation of requirements, were not perceived as separate activities*" and that "*we tried to decompose the existing RE process into smaller pieces to identify activities and their interrelations. We never succeeded. In general, at least the process we observed, was an amorph object, without a clear structure. However, we were able to identify some "micro-processes'' which can be defined in quite detailed [form] by the interviewees" e.g. "getting a decision", evaluating a prototype etc*".

Chakraborty et al. (2010) provide an extensive review of the literature on requirements engineering looking at it from the perspective of the activities involved and the objectives to be reached and problems that might be encountered. The authors take the view that much of this contribution is valuable but that it is limited because it assumes that requirements engineering is a rational, normative and deterministic process. Their view was that in practice requirements engineering activities do not typically progress in that way. They conducted extensive interviews with stakeholders in two major developments into the way that the requirements engineering process actually took place and applying a grounded theory methodology found that the requirements consultation process was often nondeterministic, chaotic and non-linear.

Aurum and Wohlin (2003) examined the RE process from the perspective of classical strategic decision making models. They suggested that strategic decision making models can provide better understanding of the decision making process and how to integrate and to improve the manageability of the RE process. These strategic decision making models have great relevance from the information systems perspective because, in strategic decision making, problem identification and the generation of solutions are key factors. In order to demonstrate the relevance it is necessary to describe one of these strategic decision making models examined by Aurum and Wohlin (2003), namely the Mintzberg model (Mintzberg, Raisinghani, & Theoret, 1976). Only the basic framework of the model is described and the reader is referred to the original paper which provides much greater detail and many illuminating examples from case studies. The model will put the analysis activities of IS analysis mentioned above into a useful perspective. Following that, the manner in which requirements fit within the model is discussed.

Mintzberg et al. (1976) suggests a model in which there are three high level phases in strategic decision making: *Identification*, *Development* and *Selection*. In the model there are seven central routines. Within the Identification phase there is a *Recognition* routine in which the opportunity, problem or crisis is recognised and another routine *Diagnosis* involving clarification and definition of the issues. The Development phase has a *Search* routine trying to find readymade solutions using *memory* (solutions which can be recalled from memory or within the organisation), *passive* waiting for a solution to be presented (e.g. by another organisation), *trap* which involves tendering to outside parties and *active* searching for solutions broadly or in a focussed way. The Selection phase involves three routines: *screen*, *evaluation choice* and *authorization*. In the screen routine candidate solutions are filtered on the basis of their feasibility and how well they achieve the goals so as to arrive a manageable set of alternatives. In the evaluation choice routine the facts are analysed and either one individual uses their judgment to make a decision or a group with conflicting goals bargain to make a decision.

Authorization involves gaining approval for a decision so as to be able to proceed. The development and selection are potentially highly iterative because a decision made in the development phase may spawn a set of sub decisions which require invoking the selection phase in order to proceed with further development.

Mintzberg's model proposes three types of routines which support the central routines described above: *decision control* routines, *decision communication* routines and *political* routines. In decision control the basic routines described are *decision planning* which is the development, monitoring and adaption of a relatively informal high level plan and *switching* which involves deciding the next step to perform. Communication control routines include *exploration* which involves general scanning of information and passive review of provided information; *investigation* which involves the focussed search for special purpose information; and *dissemination* which is the sending of information to stakeholders. Finally, political routines involve individuals or groups attempting to exert control over decisions which involve routines such as *bargaining*, *persuasion* and *co-optation*.

According to Mintzberg strategic decision making is rarely a straightforward process and involves cycling within routines or going back to earlier phases because of failures of comprehension, arrival of new information, not finding acceptable solution or solutions that are rejected and so on. Where do requirements and any requirements process come into the Mintzberg model?

Aurum and Wohlin (2003) stated that, "*Results from studies of RE processes in practice have indicated that the systematic and incremental RE models presented in the literature do not reflect the RE processes in current practice." Later they state, "In many cases, the process is an unstructured problem solving activity. In unstructured decisions, the alternatives are generally vague, difficult to compare and contrast, prioritize, or cannot be easily evaluated with respect to organizational goals and objectives.*" From the perspective of this author, one way of explaining these findings is not to try to view requirements gathering as a relatively independent process but rather to see it as lying within the Mintzberg communication control routines which support the core control routines. Information systems are, virtually by definition, information intensive and through the business processes they support have a great impact on human stakeholders; hence the requirements effort must typically be an intensive one if satisfactory solutions are to be chosen.

Viewed from a strategic decision making perspective trying to develop a universal requirements process model isolated from the larger perspective of solving organisational problems seems highly unlikely to succeed. What appears as a more effective strategy is developing one's expertise with regard to the activities associated with requirements and understanding how to perform them most effectively within the project context.

## 3.2 IS Analysis Problem Solving model

The general strategic decision making of Mintzberg can be adapted to IS analysis projects to provide a very general analysis problem solving model which covers many types of analysis projects conducted by capstone project students. This model has three phases: problem definition and scoping; solution development; and solution selection. This is shown in the figure below.

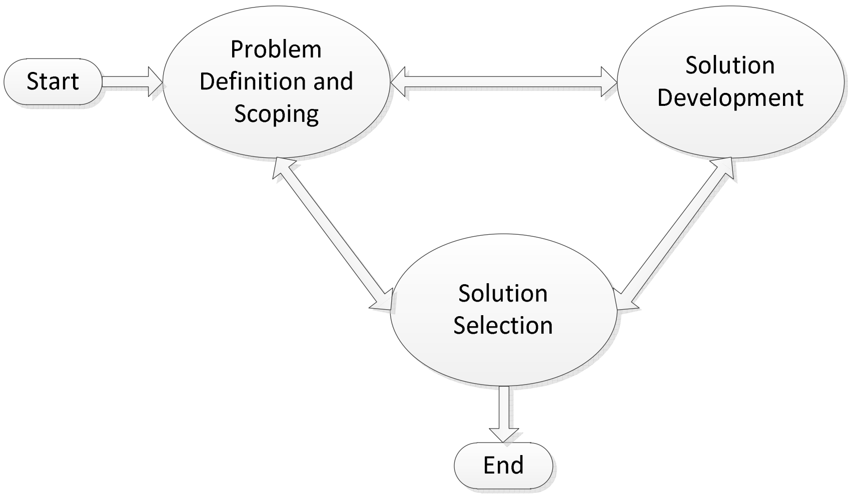


**Figure 3 IS Analysis Problem Solving (ISAPS) Model**

### 3.2.1 Problem definition and scoping

This phase involves the analyst developing an understanding of the problem context and issues involved, defining the problem (or opportunity), determining the project's goals and scoping the problem to be solved. Some initial identification of stakeholders is required in this phase. Although this is not always the case, the problems as described by clients are often poorly defined and the analyst often must work with the client and other stakeholders to reformulate the original problem, the scope and the project goals into something which can be achieved within the constraints placed on the project

(Chakraborty et al., 2010; Schenk et al., 1998)). It is important that the right problem is being addressed. Brennan (2009, p. 21) suggests, "*It is common for organizations to act to resolve the issue without investigating the underlying business need. The business analyst should question the assumptions and constraints that are generally buried in the statement of the issue to ensure that the correct problem is being solved and the widest possible range of alternative solutions are considered.*" However, this might be interpreted that the problem, goals and scope can be set at the beginning of the project and will remain static but, as the Mintzberg model and many of the agile IS methodologies suggest, problem understanding and definition, scoping and project goals may alter as more information is gained and decisions are made within the other project phases which feedback to this phase.

### 3.2.2 Solution development

This phase involves searching for potential solutions to the problem posed. Particularly from an IS perspective this typically should be wide ranging given that the primary aim is solving the business problem as efficiently as possible from the business's perspective. This aim might lead to a solution that includes very little or even no IT development. Activities involved in this phase include further investigation of the current situation and relevant issues; further research and development of existing solutions; research and development of alternative solutions. As potential solutions are found and/or developed they go to the Solution Selection phase for evaluation and possible acceptance or rejection. Alternatively, research into the development of solutions may throw further light onto the problem, issues, goals, or scope requiring a return to the problem definition and scoping stage.

### 3.2.3 Solution Selection

Solution selection is about evaluation of alternative solutions. This includes how well the proposed solution appears to meet the prioritised requirements. A solution might be eliminated very quickly if it clearly fails to meet the requirements. If there are multiple potential solutions then they will be compared to each other to determine which solutions appear to be better than others. It is possible that the first proposed solution satisfies the requirements and is selected. A proposed solution might be returned to the Solution Development phase for further development. There might be several cycles returning to the Solution Development phase to search for more potential solutions. In this phase authorization from some appropriate authority might be required; this might result in having to go back to earlier phases (e.g. a proposed solution is rejected which causes a reassessment of the project constraints or goals or a need to find another solution). The decision as to when to halt the development and evaluation of solutions requires judgment either by the analyst, client and/or other stakeholders involved as to how well any existing solutions found meet the requirements and whether further solution development and evaluation is worthwhile. In choosing potential solutions there should be consideration of how the organisation will be affected by the proposed solution and the change management issues. Being aware of and dealing with the organisational and social aspects of introducing or modifying information systems is crucial if the proposed solution is to be used as intended (Iivari, Hirschheim, & Klein, 2001; Keen, 1981). From the analyst's perspective, eventually one or more candidate solutions will be documented and presented for management consideration and the project will end with a solution selected or perhaps the project terminated without any satisfactory solution being found.

### 3.2.4 Support routines

As in the Mintzberg model, the phases above are supported by *decision control* routines related to planning and monitoring the progress of the project as a whole and decisions about the next steps to take, *decision communication* routines related to exploration for information, focussed gathering of information and the dissemination of information to stakeholders and involvement in *political* routines as the various stakeholders (including the analyst) attempt to exert control over decisions. Requirements analysis in this view is a set of activities revolving around elicitation of information, their analysis, documentation and validation but requirements analysis is not an end in itself. It should be performed in a manner and extent to which it meets the overall project needs and should evolve as the problem understanding, definition and scoping evolves rather than be viewed as an isolated step performed at a particular point in time.

The fact that IS analysis projects potentially involve many people who have some stake and interest in the outcome of the project and therefore have to be accommodated and involved, some to a lesser extent and some to a greater extent, places a great deal of emphasis on developing and maintaining effective support routines which recognize the social and political dimensions involved in IS projects (Gasson, 2006; Nguyen & Swatman, 2003; Pohl, 1993, 1994; Potts, Takahashi, & Anton, 1994). Chakraborty et al.

(2010) conclude, for example, that there is a subjective and socially constructed aspect to requirements engineering which is influenced by factors such as "*social concepts, power, control, legitimacy, privilege, justice, and equity*".

### 3.2.5 Section Summary

The IS Analysis Problem Solving model proposed above caters for a wide variety of IS analysis projects. It provides a realistic description of how IS analysis projects actually take place in real world projects. In particular, requirements gathering and documentation is placed in the larger context of understanding the problem and finding potential solutions rather than the view that is as an intermediate and relatively independent step lying between problem and solution as is often characterised by much of the literature. The model is also very accommodative of the view of IS analysis as a design process which is discussed next.

## 3.3 IS analysis and design

IS analysts face complex ill-defined problems for which they need to find solutions which will change the working environment through using or adapting existing software and hardware or through the development of new software. This process is analogous to the process that architects undertake in which clients present a complex and ill-defined problem to be solved and the architect must use existing materials or create new ones and design a product in an innovative and unique way to solve the client's problem.
IS analysis would be better described as a design activity. IS analysis is not about the application of standard techniques to solve standard problems because, while problems can often be classified broadly into various types, each problem exists in its own particular context which leads to a unique solution. Simsion, Milton, and Shanks (2012) for example found that the, "*data modeling process was perceived as having the characteristics of design processes, similar to the perceptions of architects*" . Similar arguments could be made with regard to process modelling and other activities in which IS analysts seek to change the way organisations work using IS technology. Stolterman (1992) in interviewing twenty very experienced system designers found that the traditional view of systems design was that it was substantially about "*fixing problems*", i.e. maintaining the current reality, whereas they also viewed their work as "*creative*" and "*visionary*" and thereby creating a new reality. Topi, Valacich, Wright,

Kaiser, Nunamaker, et al. (2010) state that a guiding assumption in developing latest 2010 IS curriculum guidelines was that, "*IS professionals must design and implement information technology solutions that enhance organizational performance*". However, many researchers in this area have approached the activity as one of description and their research questions often focus on the ability of the participants to correctly model a situation presented to them rather than as a design process. Research conducted with a design perspective has been very limited.

It is interesting to note that Carlsson, Hedman, and Steen (2010b) have described a relatively new course focussed on the idea of an integrated curriculum based around problem solving for business using IT. Their philosophy is that IS development should be regarded as a design process following design principles developed in other fields traditionally regarded as design.

The idea that developing information systems should be viewed as design activity is very much in keeping with the IS Analysis Problem Solving model suggested earlier rather than the standard models typically described in information systems or software engineering courses.

## 3.4 IS analysts' knowledge and skills

The initial purpose of this section is to develop a taxonomy of knowledge and skills required in IS analysis. However, some areas have greater weight or importance than others in characterising IS analysis expertise. Several distinctive knowledge and skills are suggested that differentiate IS analysts from other IT professionals operating in the same space.

The taxonomy is determined in this section by reviewing some of the more recent literature on employer surveys of the knowledge and skills required by employer bodies for IS analyst type positions together with more recent papers prescribing the knowledge and skills required by analysts. Reviewing employer surveys was regarded as being a more direct way of determining the knowledge and skill required of IS analysts rather than using curriculum guidelines or through examination of established IS degree programs. A typical Information Systems curriculum should provide the basic background knowledge and skills for a variety of roles in the information systems field (Gorgone, Gray, Stohr, Valacich, & Wigand, 2006; Topi, Helfert, Ramesh, Wigand, & Wright, 2011, p. 10). The field is broad and, hence, the information systems curriculum must, of necessity, provide breadth of coverage at the expense of depth. IS analysis is just one potential career path for an IS graduate and a curriculum may not necessarily cover all the areas expected of or needed by an IS analyst (Topi et al., 2011, p. 10). While IS curriculum guidelines exist, they are just guidelines and existing IS undergraduate courses vary widely in their content. Bell, Mills, and Fadel (2013) suggest that some part of the variability in IS courses is simply not adapting to changing needs in the information systems field and institutions teaching courses of study that reflect earlier curriculum guidelines. Given the situation with curriculum guidelines and IS courses of study, an examination of recent employer surveys about employer expectations from job advertisements for IS analyst positions would have the advantage that it was directly aligned with real world requirements. The result of the review is a “broad brush” view of IS analysts’ knowledge and skills with a reduction in the “noise” created by the any requirements of knowledge and skills for other IS (and other IT) career paths.

The second part looks at academic literature that suggests, the “distinctive skills” of IS analysts which differentiate them from other IT professionals who also might be involved in similar activities or working broadly within the same space.

### 3.4.1 IS analyst recruitment surveys

This review was a qualitative study using a thematic analysis and integration approach. The objective was to draw together the data from relatively recent surveys in the literature and from within the survey findings obtain the employers’ stated requirements for knowledge and skills expected of analysts. This data was integrated so as to build a taxonomy of IS analysts’ skills and knowledge. Unlike some other “survey of surveys”, the review, analysis and integration was not intended to integrate the findings of its component studies to a arrive at some form of meta level view of the surveys nor was it a meta-analysis as used in quantitative research in which quantitative results from a number of studies are drawn together to form what amounts to one large quantitatively based collective study e.g. see, for example, (J. Thomas & Harden, 2007, 2008; Thorne, Jensen, Kearney, G, & M, 2004) for descriptions of these approaches..

There were several factors taken into consideration with regard to the surveys selected in this analysis. Firstly, information technology, the business environment and IS development methodologies are all evolving fairly rapidly (Harris, Greer, Morris, & Clark, 2012) so it was decided to concentrate on the more recent literature (last decade or so) as this would be most relevant. Secondly, the literature draws data and conclusions from different local contexts (a city, state or country) so organisational expectations may vary somewhat depending on that local context. However, since the aim was only to determine the breadth of knowledge and skills required and not to measure how often it was requested or relative desirability amongst employers this was not deemed a serious problem. Thirdly, employers in the surveys were advertising for a variety of IT based roles but, as far as possible, this data was filtered so that it focused on the knowledge and skills of analyst based positions.

There were problems encountered in making comparisons across different studies because of terminology. Often terms used such as “technical expertise”, “analysis skills”, “functional knowledge” and “communication skills” were not well defined or left to the interpretation of the reader. Across the surveys, researchers reported their results using broad based categories of skills or knowledge which tended to be quite different, inconsistent or overlapping across papers. For example, Lee (2006) created “Business” as one of his overarching knowledge/skill categories and within that the sub category of “Social” and within that included both “interpersonal skills” and “communication skills’. On the other hand Vongsavanh and Campbell (2008) used “Communication” as one of their overarching skill/knowledge categories while Bullen (2007) used “Interpersonal” and these had some common and some differing components. These overarching categories appear to have been created arbitrarily by the researchers concerned so they were largely ignored. The lower level components within their categories, on the other hand, were closer to the original raw data and could be more precisely interpreted and used more consistently. These components were then grouped into this researcher’s set of overarching categories trying to keep some modest consistency across the original papers and familiar categories from IS curricula but, in the end, the final decision had to be a subjective one. The categories aim for independence from each other but the boundaries are not clear or precise and some particular mentioned task or ability e.g. ability to develop a technical solution may require knowledge areas and skills across several categories and could be regarded as an ability which has a sum which is greater than its individual parts. A brief description of each of the surveys used now follows.

Misic and Graf (2004) for their nationwide (North American) survey of organisations employing systems analysts defined four broad skill categories which they believed would describe the systems analyst in a holistic way. These categories were:

interpersonal skills which related to the ability to interact with others; technical skills included modelling and programming and knowledge of hardware and software; analytical skills being the "*ability to examine things critically*"; and communication skills which involved being to write and speak clearly. They found that analytical skills were regarded as the most important skill of all the categories, this was followed by technical and communication skills which were equally important and finally interpersonal skills was deemed the least important of the four categories.

Bullen, Abraham, Gallagher, Simon, and Zwieg (2009) in an extensive study spanning several years developed six broad categories of skills required by IT graduates and professionals. According to Bullen et al, organisations that produced IT products or services (which they termed "provider firms") valued project management capabilities and cited examples of skills such as project leadership and user relationship management as more important than specific business knowledge. For entry-level IT employees these organisations placed more emphasis on the business and project management skills rather than on technical skills. On the other hand, other organisations (i.e. non provider firms) tended to hire people for their technical capabilities such as programming and systems analysis skills. Programming was seen as necessary by employers mainly on the basis that this provided a good grounding in analysis and problem solving and would also allow systems analysts to deal more effectively with programmers in the future. All firms hiring at the mid-level range (defined as those positions requiring at least five years' experience) ranked project planning, project leadership and user relationship management as their top three skills.

Lee (2006) examined recruiting advertisements from the year 1990 to 2004 in Hong Kong to determine the skill requirements of IT professionals in that region of the world. For those positions classified as systems analysts a combination of business, technical and system skills were required. The emphasis was slightly more on business skills over technical and system skills. It is worth noting that under the category of business skills were the terms leadership, organisation, project management, planning, monitoring and control as well social skills such as communication, independence, motivation and interpersonal skills. Given the range of skills within that category, it is not surprising then that for IT project managers business skills was the predominant requirement.

The work by Vongsavanh and Campbell (2008) on analysts' skills and knowledge reviewed both the academic and practitioner literature as well as interviewing analysts within a particular organisation. They identified specialisations of the analyst role depending on the organisational unit in which the analyst was based. Those based within business units of an organisation were typically called business analysts whereas those based within IT units were typically called systems analysts. Both specialisations were expected to have technical knowledge and skills (hardware, software and applications), be involved in business process improvement, act as mediators between business groups and IT groups, have good communication and interpersonal skills, modelling skills, problem-solving skills and general analysis skills. Those based within business units were expected to have greater knowledge relevant to the particular business area in which they were based, were more likely to be involved in business problem analysis and were expected to show leadership and selling skills (i.e. promotion of new systems and obtaining client buy in). On the other hand those analysts based in IT units were expected to demonstrate greater technical knowledge and were more likely to be involved in technical implementation and maintenance and to act as an Information Systems standards regulator.

Noll and Wilkins (2002) surveyed organisations employing information technology majors at a mid-Western University in America in order to ascertain the types of skills and knowledge required by analysts, programmers and end-user support personnel. Those who responded to the survey were middle and senior level managers within those organisations. For the analyst group the most important skills or knowledge were business knowledge, knowledge of advanced IS applications, and systems planning. They noted that “soft skills” i.e. communication and interpersonal skills were becoming increasingly important in all areas of IS.

### 3.4.2 Integration of results

Table 1 (Comparing Studies) selects out the knowledge and skill areas from each of the surveys with a column assigned to each study with the items mentioned in the column relating to the lowest (i.e. most basic or concrete) level areas of knowledge and/or skills reported. At times a skill or knowledge area was not clear from the context and required interpretation by this author and sometimes there was some rewording of the terms used in the original paper. Any errors or misinterpretation are entirely the fault of the author who hopes that these will not offend the researchers concerned.

The last column of the Table 1 assigns the knowledge or skill area mentioned in the survey to a category assigned by this author. The categories developed were (in no particular order of importance):

**Critical Thinking skills**
- conceptualization, analysis, synthesis, evaluation
- clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness

**Interpersonal skills**
- ability to work cooperatively with project stakeholders
- diplomacy, negotiation and expectation management
- persuasion (e.g. promoting or selling a new system)
- leadership - ability to influence others to follow a goal or plan

**Communication skills**
- reading, writing, public speaking, teaching/training

**ISD Process Knowledge and skills**
- ISD methodologies, models, techniques
- project planning, management and organisation
- risk management
- solution design

**IS applications Knowledge and skills**
- knowledge of typical IS application software, how they can used in organisations, their advantages and disadvantages and awareness of relevant standards (e.g. IT/IS, legal, governmental)

**Technical knowledge**
- IT hardware, its evaluation and selection of hardware
- programming (in some appropriate language)
- communications technology
- database technology and implementation
- relevant IT/IS standards
- security

**Personal Attitudes and abilities**
- motivated, Independent, trustworthy, curious, organised, forward planning
- capacity for learning and reflective thinking

**Problem solving skills**
- problem determination and framing
- problem solving techniques and methodologies
- creativity and innovativeness

**Organisational Knowledge**
- general knowledge regarding organisational strategy, structure, culture and behaviour.

**Business Knowledge**
- general knowledge about business principles and practices, common functional areas of business such as accounting, human resources, marketing, sales etc.

**Problem domain knowledge**
- knowledge of the specific problem domain area under investigation
- focus on specific people, processes, organisational area, historical, social and technical issues applying to the problem domain

These suggested categories are broadly consistent with the IS 2010 Curriculum Guidelines for Undergraduate Degree Programmes in Information Systems (Topi, Valacich, Wright, Kaiser, Nunamaker, et al., 2010) which, for example, suggests three broad areas:

Information Systems Specific Knowledge and Skills

- Identifying and designing opportunities for IT-enabled organizational improvement
- Analysing trade-offs (ability to design and compare alternative solutions)
- Designing and implementing information systems solutions
- Managing ongoing information technology operations

Foundational Knowledge and Skills

- Leadership and collaboration
- Communication (e.g. listening, observing, interviewing, writing, presenting)
- Negotiation
- Analytical and critical thinking, including creativity and ethical analysis
- Mathematical foundations (e.g. statistics, probability, algorithmic thinking, discrete mathematics)

Knowledge and Skills Related to Domain Fundamentals

- General models of the domain (which provide overall understanding of the domain)
- Key specializations within the domain (e.g. it is suggested that in the business area finance, accounting, marketing, and management (both organizational behavior and strategy) are fundamental and thereafter some further specialization)
- Evaluation of performance within the domain (which may be specific to the domain of interest)

Some differences with Topi (2010) observed are their inclusion of:

- managing ongoing IT operations which is not especially relevant to IS analysis but is consistent with the guidelines' need to provide a broad IS education
- mathematics which is qualified depending on the specific speciality of the IS professional so its exclusion from the author's proposed list is that it could be regarded as a problem domain specific knowledge and skill

and exclusions of:

- programming which was core in the previous Curriculum Guidelines but still appears as an elective study (and still appears as a core unit of some IS courses)
- personal attitudes and abilities which, however, is mentioned in another part of the guidelines that mentions that IS professional should "*demonstrate persistence, flexibility, curiosity, creativity, risk taking, and a tolerance of these abilities in others*" (Topi, Valacich, Wright, Kaiser, Nunamaker Jr., et al., 2010, p. 8)

## Table 1 Comparing Studies

| Misic and Graf (2004) | Lee (2006) | Vongsavanh and Campbell (2008) | Noll and Wilkins (2002) | Bullen (2009) | Skill/ Knowledge area | Suggested category |
|---|---|---|---|---|---|---|
| communication | business | | Business knowledge | Non-technical (communications) | Write documentation clearly and effectively (e.g. reports, manuals) | Communication skills |
| communication | business | presentation | Business knowledge | Non-technical (communications) | Deliver presentations clearly and effectively | Communication skills |
| analytical | | General Analysis (generic analysis skills) | | | Examine critically | Critical Thinking |
| analytical | Systems (Development methodology) | General Analysis (generic analysis skills) | | | Ability to breakdown a broad situation into individual components | Critical Thinking |
| | | Problem solving | | | Judgment | Critical Thinking |
| | Business (functional) | Business knowledge | Business knowledge | Non-technical (problem/opportunity skills) | Business domain /industry knowledge | General business knowledge |
| | Business (functional) | Business knowledge | Business knowledge | Non-technical (problem/opportunity skills) | Business function specific knowledge | General business knowledge |
| | | | Business knowledge | | Understand business problems | General business knowledge |
| | | | Business knowledge | | Understanding of business environment | General business knowledge & Organisational knowledge |
| interpersonal | Business (social) | Communication | User support | Non-technical (Relationship) | Work with end users and management | Interpersonal skills |
| interpersonal | Business (social) | Communication | Business knowledge | Non-technical (Relationship) | Work in team/collaborative environment | Interpersonal skills |
| interperson | Business | Communication | Business | Non-technical | Work with IT | Interpersonal skills |

| | | | | | | |
|---|---|---|---|---|---|---|
| al | (social) | | knowledge | (Relationship) | professionals (non analyst) | |
| | | | | Non-technical (Relationship) | Managing stakeholder expectations | Interpersonal skills |
| | | Leadership | | Non-technical (Relationship) | Diplomacy/Negotiation | Interpersonal skills |
| Leadership | business | leadership | Business knowledge | Non-technical (project planning) | Leadership | Interpersonal skills |
| | | Selling | Business knowledge (deliver persuasive presentations) | | Promote a new system to users (user buy-in) | Interpersonal skills |
| | | | Advanced IS applications | | Knowledge of advanced IS applications (e.g. ERP, CRM, KBS, expert systems, AI) | IS Applications knowledge |
| | | | | Technical skills (essential skills) | IT/IS standards | IS Applications knowledge & Technical knowledge |
| technical | | Elicitation | Programming (database modelling)) | Technical(essential) | Apply ISRD modelling techniques (data, process, use case etc) | ISD Process Knowledge |
| | | Technical | programming | Technical (essential skills and foundational skills) | Database analysis and logical design | ISD Process Knowledge |
| | Systems (Development Methodology) | | IS Systems Planning | | Systems analysis (assumed to mean IS methodology and modelling) | ISD Process Knowledge |
| | | | IS Systems Planning | | IS planning, management and evaluation | ISD Process Knowledge |
| Project planning | Business (management) | | Business knowledge | Non-technical (project planning) | Project planning, management and | ISD Process Knowledge |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | organisation | |
| | | | | Non-technical (project planning) | Project risk management | ISD Process Knowledge |
| | elicitation | elicitation | | | Interviewing | ISD Process Knowledge & Interpersonal skills |
| technical | Technical (software) | | Programming | | Use software development tools | ISD Process Knowledge & Technical knowledge |
| | | | | Non-technical (problem/opportunity skills) | Change management and organisational readiness | Organisational knowledge |
| | Business (social) | Business knowledge | | | Independence and motivation | Personal attitudes |
| | | | | Non-technical (problem/opportunity skills) | Company specific knowledge | Problem domain knowledge |
| | Systems (problem solving) | Problem solving | | | General Problem solving | Problem solving skills |
| | Systems (problem solving) | | | | Creativity and innovation | Problem solving skills |
| | | | Business knowledge | | Develop appropriate technical solutions for a business problem | Problem solving skills & Problem domain knowledge & Technical knowledge & IS Applications knowledge |
| | | | | Non-technical (problem/opportunity skills) | Business process reengineering | System development process & IS Applications knowledge & General business knowledge |
| | | | IS Systems planning | | Hardware evaluation and selection | Technical knowledge |
| technical | Technical (software) | | IS Systems planning | | Hardware knowledge (desktop, | Technical knowledge |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | mini, mainframe) | |
| technical | Technical (software) | | | Technical (foundational) | Software knowledge (coding/programming in various types of languages) | Technical knowledge |
| | Systems (problem solving) | | | | Technical expertise | Technical knowledge |
| | | | IS Systems Planning | | Information access and security | Technical knowledge |

The common categories of knowledge and skills required within all the studies were interpersonal skills, communication skills, ISD process knowledge and technical knowledge. However, within a category there were also significant differences in terms of the details of what was included and excluded in the original articles. It should be acknowledged that in some cases the study related to employers describing entry knowledge skills for various job roles and so candidates might later need to acquire further knowledge or develop further skills. More senior job roles advertised would require more experience and would expect a different mix and depth of knowledge and skills but assuming that they were still in the IS field there is no obvious reason to suppose that this would introduce entirely different knowledge or skills categories. In the context of novice and expert differences therefore it is assumed that the proposed set of knowledge and skills above is reasonably comprehensive.

### 3.4.3 Distinctive knowledge and skills

Two areas of distinctive competence for Information Systems analysts have been suggested, namely, IS Process Knowledge and IS Applications Knowledge (Iivari et al., 2001; Iivari, Hirschheim, & Klein, 2004). These are described as distinctive because they are areas which differentiate them from other professionals working in roughly the same space e.g. business analysts and systems analysts. They represent knowledge and skills which other professionals will have awareness of but which would not be regarded as expected strengths or areas of particular excellence by those other professionals.

The first distinctive skill proposed is application knowledge which they explain is "*knowledge about typical applications, their structure, functionality, behaviour and use,* *in a given application domain, and knowledge of possibilities to support the application domain using IT*". Iivari et al. (2004) deliberately use the term "*IT artefact*" rather than Information System to broaden the concept of information systems software as encompassing newer communication technologies such as mobile phones and tablet computers. Further, it is suggested that the ISAD analyst should be following and understanding trends such as Social Networking, Software-as-Service, Cloud computing, Ubiquitous Mobile Computing, Platform-as-a-Service and so on to determine how these might be used effectively in organisations.

The second area of distinctive competence mentioned by Iivari et al. (2004) is in Information Systems development process knowledge containing the competencies of "

(1) *expertise of aligning IT artifacts with the organizational and social context in which the artefact is to be used;*

(2) *identifying and specifying the needs of people who are supposed to use the system (user requirements construction);*

(3) *organizational implementation; and*

(4) *evaluation/assessment of these artifacts and related changes"*

The need for IS analysts to have competence in the organisational change aspect of implementing IT projects is supported by Paré and Jutras (2004) who stress the importance of change planning, dealing with individual reactions to change and the evaluation of the change.

### 3.4.4 Core IS analysis activities

In comparing activities performed by business and systems analysts Vongsavanh and Campbell (2008) found that there was a set overlapping activities across both business analyst and systems analysts which are suggestive of the core activities of the IS analyst:

- **business problem analysis** –understanding and defining the business problem
- **business modelling** –analysis and modelling of current and future business functions and processes.
- **IS strategy evaluation** –evaluating information system strategy in relation to the longer term business needs and goals
- **requirements elicitation** –gather requirements from stakeholders and document these requirements. Business performance was specifically mentioned as not being of concern in the analyst's role.
- **mediation** –liaison support between users or business professionals and IT professionals.

- **solution design** –high level design of new business functions or processes. A key aspect of the analyst's role in solution design is to facilitate business input into the solution as well as getting approval for the various options that might be provided.

To these can be added

- **change management** - consider the organisational change management implications to ensure successful implementation of the chosen solution.

This last activity was mentioned by Iivari et al. (2004) and also supported by Paré and Jutras (2004). It appears to be an increasingly important activity performed by IS analysts. Evaluation of IS systems has also been mentioned as an important activity (e.g. in (Topi, Valacich, Wright, Kaiser, Nunamaker, et al., 2010) and (Iivari et al., 2004)) which could have been included but was omitted because it appeared to be an activity which was more aspirational ("should be") than actual ("actually being done") activity at this point in time.

### 3.4.5 Section Summary

This section of the work established the activities performed by an IS analyst and demonstrated the correspondence of those activities to the activities performed by IS students involved in capstone projects which are the subject of this research. It also reviewed some of the literature on the overall process involved in IS analysis which included reference to literature on requirements engineering and argued that these models are not an adequate reflection of the IS analysis process. Another model drawn from the management literature by Mintzberg et al. (1976) was proposed as being a more accurate reflection of the IS analysis process and which involved problem definition, solution development and solution selection facilitated by a number of support routines. This lead to the model proposed for IS analysis (ISAPS) described earlier which suggests a more chaotic and iterative process than is often portrayed in the academic literature.

By reviewing the knowledge and skills for IS analysts (or as near as could be determined to this type of role) in more recent recruitment surveys and comparing it with the most recent IS curriculum guidelines (Topi, Valacich, Wright, Kaiser, Nunamaker, et al., 2010) a set of knowledge and skills areas were established. Following that the literature on what were regarded as the distinguishing knowledge and skills areas was reviewed to arrive at areas which characterised the IS analysts and differentiated them from other business or IT professionals who operated in broadly the same space. Finally, seven core activities were also suggested, namely, business problem analysis, business modelling, IS strategy evaluation, requirements elicitation, mediation, solution design and change management.

## 3.5 IS Analyst Expertise

### 3.5.1 Introduction

In this section literature regarding IS analyst expertise is reviewed and discussed. The previous section described the activities in which IS analysts are involved, the process of how they go about doing those activities and areas of knowledge and skill they should possess if they are to operate as IS analysts. However, in this section the discussion now turns on how well the IS analyst is able to accomplish the analysis tasks and so one might characterise the discussion as much more about knowing how “to do” IS analysis and how well it is done rather than “knowing about” IS analysis.

A difficulty encountered reviewing the literature on IS expertise was terminology used by the various researchers. The term “novice” was used in various articles and at one end of the scale was used to describe students in the early stages of their course of study while in others it referred to practising analysts with several years’ experience. Similar difficulties occurred with the term “expert”. There was a tendency to use the term in a relative sense i.e. within the cohort being studied the best/most experienced ones were experts and weakest/least experienced were the novices. Another point of confusion was that sometimes years of experience was equated with expertise by the researchers and as the literature on expertise suggests, years of experience in an area often correlates poorly with expertise in that area.

Two other issues with regard to novice-expert studies in activities performed by IS analysts (amongst others) are highlighted by Simsion et al. (2012). Simsion is a very experienced “real world” data analyst who conducted an extensive literature review of novice-expert differences in data modelling (Simsion, 2007; Simsion & Witt, 2004). Simsion et al highlighted two issues namely, the demographics of the subjects whose skills were being tested and the other was the very limited perspective from which the IS analysis process was being studied.

Simsion et al. (2012) criticized the extensive use of students or recent graduates in studies related to data modelling. Simsion et al. (2012) summarised the findings stating, "*Most empirical studies have used students as participants; of course, this limited the difficulty of the problems posed. Of the total of 3210 participants across 59 studies that we surveyed, only 147 in nine studies had more than one year's industry experience of data modeling. Thus most studies used unrealistically simple data models.*" They give as an example a conclusion that novice data modelers have little trouble with data modelling because they were able to identify entities, attributes and relationships correctly from a description of a situation effectively designed within the scope of the limited abilities of the subjects. Clearly, Simsion et al were sceptical of findings from these types of laboratory style studies in data modelling. Eteläpelto (1998, p. 86) makes the same criticism about the lack of professional analyst/designers in Information Systems design studies.

Simsion et al. (2012) also took issue with the fact that many studies focused heavily on modelling as representation rather than as design. This type of study tests the ability of the subject to model a given situation described as an "as-is" description. Simsion et al suggest that "as-is" descriptive modelling is the "*trivial part of the process*" and that the real skill is in design where the practitioner must understand the entire problem context and design an appropriate solution which must satisfy a variety of goals and constraints. Further, they suggest that these design skills are exemplified by the experts and not by the novices. If we relate this back to the IS analysis process model proposed in this thesis (based on Mintzberg et al. (1976)) the model suggests strongly that descriptive modelling represents only a small part of the overall process of problem understanding, solution research and selection just as Simsion et al stated. There is a danger of trying to infer far more than is warranted about novices and experienced practitioners based on only a very limited aspect of the analysis process as it occurs in the real world.

Schenk et al. (1998) suggests that to facilitate the analyst's progression from novice to expert requires three steps *"(1) understanding how a novice analyst functions, (2) understanding how an expert analyst functions, and (3) quickly and efficiently closing the gap between the two.*" The next section reviews the literature related to Information Systems expertise in order to determine what has been found previously with regard to steps one and two and the gaps that exists between novices and experts.

### 3.5.2 Developing expertise in IS analysis

A review of the literature related to IS analysts was conducted with the aim of determining the attitudes, qualities, knowledge and skills that set those perceived as being expert, superior or exceptional apart from others in the same field.

There were two broad approaches to determining superior performance observed in the literature:

- Studies comparing analysts in the field i.e. working in their jobs as analysts (Curtis, Krasner, & Iscoe, 1988; Hickey & Davis, 2003; Khan & Kukalis, 1990; Stolterman, 1992; Tan, 1994; Wynekoop & Walz, 2000). The data was largely gathered via interviews or surveys from the analysts or peers or managers of analysts. The data is qualitative and is very “noisy” in the sense that the analysts are working across different IS projects doing somewhat different tasks making assessments about what constitutes superior performance and using terminology that is not well defined but, in spite of all those issues, when aggregated the data does provide broad features about those things which differentiate superior analysts from the average and novice analysts.
- Studies in “laboratory style” conditions with analysts of varying ability and experience who are asked to work on a problem or situation presented to them by the researcher who then studies their approach to dealing with the problem or issue (Adelson & Soloway, 1985; Dinesh Batra & Davis, 1992; Mackay & Elam, 1992; Schenk et al., 1998; Sutcliffe & Maiden, 1992; Vitalari, 1985; Vitalari & Dickson, 1983). These studies have several potential problems: they are conducted out of the context of a real project setting; they involve relatively small scale problems (sometimes disparagingly described as “toy” problems) and experienced professionals (and even more so experts) who have internalised great deals of knowledge and skills may struggle to articulate what they do. There are limitations therefore regarding the extent to which these types of studies capture expertise. For all the limitations, however, the data and inferences from analysing the data is at least indicative of approaches, attitudes, knowledge and skills of the analysts within the limited window from which they are observed.

It is clear that expert analysts must have broad knowledge and skills based on the knowledge and skill areas developed earlier. It is also clear that the degree of competence required in the different areas varies as one develops expertise. These areas ranged from having what might be described as needing a solid working knowledge and skills through to exceptional level of knowledge and skills.

In the following, the research pertaining to each area of knowledge and skill is discussed individually (except for problem solving and problem domain knowledge). The order of presentation was simply based on the amount of material found corresponding to that area so the reader will find correspondingly more material as they progress through each area.

#### 3.5.2.1 IS applications knowledge

IS applications knowledge was not mentioned directly in any of the novice-expert studies in spite of the fact that it figures as a key area of knowledge and skill for IS analysis. This might be explained because IS applications knowledge is not a familiar term and the concept might be subsumed under technical knowledge or under IT knowledge or even problem domain knowledge i.e. software applications solutions relevant to a problem domain. Also, businesses now typically use or adapt existing application software (and even more now with the emergence of cloud computing (Kulkarni, 2012; Marston, Li, Bandyopadhyay, Zhang, & Ghalsasi, 2011) and SaaS (Agrawal, Candan, & Li, 2011; Verma, 2010)) rather than develop software from scratch because of its cost effectiveness. This was a less significant factor at the time that most of the studies being referred to in this research were conducted.

#### 3.5.2.2 Technical knowledge

Exceptional or top performing IT professionals were judged to have a high level of *technical knowledge* Wynekoop and Walz (2000) and was found to be one of the top ten traits of “top performers”. However, it should be mentioned that their study related to IT developers. Curtis, Walz, and Elam (1990) in studying software design of large systems mention on numerous occasions the technical involvement required and indeed the technical “vision” displayed by exceptional designers. In the case of IS analysts it is clear that some technical knowledge is required and assumed (e.g. see (Schenk et al., 1998; Vongsavanh & Campbell, 2008)) but novice-expertise studies have not focused on this area. In spite of this, it seems reasonable to speculate based on the result that IS applications knowledge and skill was considered as one the key areas for IS analysts, with technical knowledge close behind, that it is likely that expert IS analysts would demonstrate reasonably strong knowledge and skills in these areas.

3.5.2.3 Business Knowledge

In terms of general business knowledge, Wynekoop and Walz (2000) found that top performing IT developers possess *business knowledge*. Curtis et al. (1990) also mention the need for exceptional designers to possess business knowledge. Neither of these studies, however, place particular stress on having high levels of business knowledge. However there is the need to work collaboratively with business stakeholders in an IS development and to understand the business problem context indicates the need for a solid understanding of business.

3.5.2.4 Organisational Knowledge

Vitalari (1985) found that high ranked analysts (as judged by peers and superiors) relied on organisational knowledge. However, while neither high ranked analysts nor low ranked analysts in the study demonstrated a sophisticated understanding of organisational politics the high ranked analysts demonstrated some interest whereas the low ranked analysts "*exhibited virtually no interest*". The high ranked analysts showed interest in the "real" motivation for the system or the prime mover behind system development.

3.5.2.5 Personal Attitudes and Capacities

There were a number of personal attributes or capacities that were associated with exceptional or expert analysts. Those that were regarded as exceptional or top performing were ***dependable*** (Curtis et al., 1988; Wynekoop & Walz, 2000), ***motivated*** (Wynekoop & Walz, 2000), ***organised*** (Stolterman, 1992; Wynekoop & Walz, 2000), ***value autonomy***, ***prefer challenging work***, and ***tend to work hard*** (Smits, McLean, & Tanner, 1993) and were ***creative*** (Stolterman, 1992; Wynekoop & Walz, 2000). Dinesh Batra and Davis (1992) stated that the experts in their study demonstrated a ***more detailed and systematic*** approach to information gathering before addressing representation aspects. Even in problem situations that were unfamiliar to novices, experienced and expert designers, Adelson and Soloway (1985) found that experts were able to outperform because they were ***more disciplined and systematic***.

3.5.2.6 Critical Thinking

Top performing or exceptional analysts were regarded as ***logical*** (Stolterman, 1992; Wynekoop & Walz, 2000) and ***analytical*** (Wynekoop & Walz, 2000). They were able to ***think creatively*** (Wynekoop & Walz, 2000). They were ***able to integrate knowledge***

***areas*** (Curtis et al., 1988). While Wynekoop and Walz (2000) state that exceptional analysts were able to think abstractly, Adelson and Soloway (1985) make the stronger claim that experts were able to able to outperform because of their ability to ***structure problems into different levels of abstraction*** which lead to more effective mental models. Topi, Valacich, Wright, Kaiser, Nunamaker Jr., et al. (2010) in the IS 2010 Curriculum Guidelines for example has as one of five guiding assumptions that, "*IS professionals must have strong analytical and critical thinking skills to thrive in a competitive global environment.*" The studies examined here suggest that the ability to think critically in all the areas mentioned above is necessary to be considered as an expert.

#### 3.5.2.7 Communication Skills

Expert IS analysts should possess exceptional communication skills. In a survey of MIS professionals and non-professionals Khan and Kukalis (1990) found that communication skills were the highest ranked skill requirement in order to progress from programmer to systems analyst. To progress from systems analyst to project leader communication skills followed by interpersonal skills were the two highest ranked requirements. Curtis et al. (1988) undertook a field study interviewing those involved in software development projects. They concluded that exceptional designers were skilled at communicating their technical vision and "*usually possessed exceptional communication skills and often spent much of their time educating others about the application domain*". It seems clear that experts showed significantly better communication skills than the average IT professional. However, this skill also seems to be integrated with other skills related to having something significant to communicate (an idea, plan or vision) and having the interpersonal skills to connect with others.

#### 3.5.2.8 Interpersonal Skills

In general, it appears that exceptional Information Systems analysts are people oriented (Vitalari, 1985) and are able to work within and lead teams (Wynekoop & Walz, 2000). Experts were very much aware of the importance of teamwork with regard to the requirements elicitation process to the point where they would, for example, suggest team building techniques prior to requirements elicitation so as to develop mutual trust and build communication (Hickey & Davis, 2003). Experts regarded conflict avoidance and resolution as important and would make themselves aware of the power structures and politics in place within the problem domain as part of the requirements elicitation process so as to minimise conflict and had strategies for resolving conflict (Hickey & Davis, 2003).

Tan (1994) was interested how analysts develop mutual understanding and rapport with their clients. She studied twenty eight practising analysts' verbal and non-verbal behaviours as they interviewed clients to determine problems and requirements. Tan did not specifically describe the work in terms of exceptional or expert analysts however her results did find particular behaviours and attitudes by the analysts were more successful than others on a number of measures of mutual understanding and rapport. Key findings were that better behaviours were

(1) Finding the appropriate balance between seeking and stating information. Analysts spending too much time stating information were thought by the client to be not listening and having preconceived ideas
(2) Summarizing, reviewing and paraphrasing information that the analyst believes the client has not understood or to emphasize key points
(3) Keeping the conversation on track by controlling information
(4) Being prepared to interrupt to paraphrase or summarize points made by the client as means of establishing mutual understanding
(5) Being able to change the clients perspective so that they could see the problems being faced by the analyst by asking appropriate questions or prompting
(6) Providing nonverbal cues to the client which indicate to the client that they are interested in what they have to say e.g. looking at the client while they are speaking, leaning forward and nodding at appropriate times

#### 3.5.2.9 Problem Solving Skills and Problem Domain Knowledge

The following section reviews the literature on problem solving skills. In reviewing the literature however it became apparent that problem solving was inextricably linked to problem domain knowledge and hence the combination of the two knowledge areas. However there need to be two distinctions made. The first is the distinction between general problem solving skills and problem domain problem solving skills. General problem solving skills (e.g. means–end analysis, difference-reduction method, working backward etc.) might be appropriately used in any problematic situation and these skills have been categorized under "personal attitudes and capabilities" whereas there is the specific knowledge gained by actively working in a particular problem domain which gives insight into aspects such as the issues on which to concentrate, strategies have been effective before and solutions that have worked in the past. Without specific problem domain experience, a novice must use more general approaches, spend time on issues out of proportion to their importance, and explore a wider net of potential solutions and so on. In practical situations where resources (e.g. time and money) are limited the novice is less likely to be able to work as efficiently from problem understanding through to a finding a satisfactory solution. The other distinction relates to problem domain expertise as it relates to the IS analysis task (e.g. finding a suitable system for student administration for an educational institution) as opposed to problem domain expertise as it relates to the subject matter (e.g. the administrator who understands and solves students' problems related to student administration). While a subject matter expert (by definition) is very familiar with the problem domain area (which in this thesis has been categorized as "business knowledge"), the expert IS analyst only needs to learn enough about the problem domain to understand the problem and issues but then applies their IS knowledge and skills to work toward the development of a satisfactory IT based solution. The subject matter expert, without IS analysis knowledge and skills, will not be able to move beyond their subject matter expertise to arrive at a satisfactory IT based solution without strong support with the IS/IT aspects (McGinnes, 2000).

Schenk et al. (1998) summarized the difficulties of novices in the problem-solving process finding that novices had difficulty recognising the existence of a problem, defining the correct problem, using the available information, recognising or questioning assumptions, considering a wide range of alternatives and addressing implementation issues. Others have also found that novices have difficulty with problems in which there no single, simple, well known or "correct" solution (Connolly & Begg, 2006; DeGrace & Stahl, 1990; Fitzgerald, 1998).

In the following, the ways in which experts approach problem solving in IS analysis are discussed in more detail and in doing so it becomes clearer how expert IS analysts think and why they are able to perform IS analysis more effectively than novices.

*3.5.2.9.1 Adopting a more holistic approach*

Schenk 1998 (Schenk et al., 1998) describes Information Systems analysis as "*a semantically rich professional domain largely characterised by ill-defined problems*". Experts deal with such complexity by taking a holistic view of the problem domain, "see" some key defining characteristics and are able to categorise the situation in a top down manner according to some variant of a problem type relevant to IS. This approach is observed generally in similar professional domains; for example, Mackay and Elam (1992, p. 151) concluded that "*experts are inclined to approach problems from the top down and are able to group problems with the same underlying structure*". With novices, however, Mackay and Elam found that in similar problem domains "*novices tend to use a bottom-up procedure which lacks a comprehensive plan, and they usually group problems by surface characteristics*". This "*poor scoping and structuring of the problem*" resulted in reduced performance of novices (Sutcliffe & Maiden, 1992). When it came to finding solutions, Vitalari (1985) found that exceptional analysts "*showed greater concern for the impact of constraints on solutions and modified the solution space accordingly*" which suggests a more holistic approach to finding solutions that would actually solve the problem

*3.5.2.9.2 Broader and deeper understanding of the problem domain*

Problem domain knowledge is essential to IS analysts in order to understand and specify problem statements, goals and requirements and to test the consistency of requirements. This knowledge is drawn upon to highlight important information and to simulate either explicitly or in analysts' mental models to simulate scenarios of system behaviour (I. L. Huang & Burns, 2000). When comparing novices and experts, Schenk et al. (1998) found, using protocol analysis, that experts explicitly mentioned significantly more domain specific issues than novices which demonstrated "*a greater breadth of domain-specific knowledge among experts compared to novices*".

*3.5.2.9.3 Better ability to map between the required business behaviour and computational structures*

Curtis et al. (1988) highlighted that exceptional designers were extremely familiar with the problem domain and that, "*their crucial contribution was their ability to map between the behaviour required of the application system and the computational structures that implemented this behaviour*". Schenk et al. (1998) state that "*Domain-specific experience is one key in the movement from novice to expert. Experience entails rehearsal of judgment strategies, generation of new strategies in the face of new situations, general learning by trial and error, and an increasing awareness and familiarity with the types of domain problems and their structure*".

*3.5.2.9.4 Selection of more appropriate problem solving strategies*

Having categorized the problem, this triggers multiple problem-solving strategies in experts which are found to be more effective than those triggered in novices for domain-specific issues (Schenk et al., 1998). Somewhat surprisingly, Schenk et al. (1998) found that in the IS area "*novices verbalize significantly more strategies than do experts*". This was in contrast to earlier work which suggested that experts have a richer store of alternative strategies based on their experience with different problems. Schenk suggested that "*novices may verbalize large numbers of strategies, but these strategies may be of a more general nature than those of experts*". Schenk et al. (1998) states at another point that, "*… novices verbalize strategies that resemble a standard textbook enumeration on proper systems development steps.*" In contrast, "*experts provide a much more detailed specification of their strategies. The expert analysts seem more precise about what issues must be resolved for a successful solution.*" This is consistent with the internalised nature of expert knowledge so that inappropriate or weaker strategies are unconsciously discarded and experts only become consciously aware of the strongest strategies which also emerge in a more detailed form indicating that they are tapping into a broader and deeper problem solving knowledge structure.

The triggering of more effective problem solving strategies in experts for domain specific issues suggests that it is their experience which allows them to do so. In the search for solutions one can adopt a forwards search strategy or a backwards search strategy. In a forwards search strategy one starts with the information given and works towards the solution while on the other hand in a backward search strategy one starts with a solution and work backwards towards the problem. In other areas of problem solving experts tend to adopt forward search strategies while novices tend to use backwards searching solution strategies. However as the complexity of the problem increases experts and novices also adopt more backward search solution strategies (Schenk et al., 1998). With regard to more complex problem solving it would appear that if the expert does not have sufficient prior knowledge to draw from, they must resort to some of the more general problem solving approaches adopted by novices. Chakravorty, Hales, and Herbert (2008) suggested that solving complex problems is not the relatively straightforward process sometimes presented in literature and that the process in practice can be highly chaotic and that the analyst must work holistically amongst problem scoping, requirements gathering and solution search activities. In these complex cases, factors such as personal attitudes of patience, discipline and tolerance for uncertainty might be important factors in problem solving which differentiate the novice from the expert.

*3.5.2.9.5 More time taken but better solutions*

While research has found that expert problem solving involves many automatic processes which suggests experts should solve problems more quickly than novices, this seems to be more obviously true predominantly in more structured domains (e.g. the classic cases of chess or standard mathematical problems and so on). In complex and information rich domains typically involved in information systems analysis, experts may well take longer to solve problems than novices. For example Schenk et al. (1998) found that in their laboratory style experiment in which novice and experienced analysts were asked to develop a set of requirements for a given case study the more experienced analysts took on average 58 minutes to finish the task compared to novices who took on average only 37 minutes. One reason for this appears to be that knowledge structures of novices are relatively superficial and sparse compared with those of experts and so they may miss higher level aspects of the problem domain as well as lower level details (Atwood, Turner, Ramsay, & Hopper, 1979; D. Batra & Davis, 1989; Sutcliffe & Maiden, 1992). Experts in information systems analysis are more disciplined and systematic in gathering information compared to novices (Dinesh Batra & Davis, 1992) and try to develop a more holistic understanding of the problem domain before progressing further with, for example, attempting to develop descriptive conceptual models. The result is that experts may take significantly longer than novices to develop solutions but this approach results in solutions which are more soundly based.

The effect of varying levels of existing problem domain knowledge on expert software designers was investigated by Adelson and Soloway (1985). When faced with an unfamiliar domain and task, expert analysts still outperform novices and less competent (but experienced) analysts. This is because they were more systematic in their investigation and that they were better able to structure the problem into different levels of abstraction that lead mental models that allow simulation of the system. Increasing familiarity with the domain and systems simply increases the rapidity with which the expert is able to develop appropriate solutions and draw on experience for aspects that can be reused.

*3.5.2.9.6 More effective hypothesis testing to reduce uncertainty and ambiguity*

An important way of reducing complexity in information rich and complex situations is to have a systematic way of reducing uncertainty. Suitably characterising the type of problem and selecting an appropriate strategy sets a general direction forward but there is still a great deal of complexity and uncertainty that exists in the form of, as yet, unknown facts, assumptions, decisions etc. This complexity and uncertainty can be reduced either by determining the facts, assumptions, decisions et cetera or eliminating them from consideration because they are considered highly unlikely or insignificant or irrelevant. The testing and elimination process is described in the literature as "hypothesis testing" which Schenk et al. (1998) describes as "*behaviour wherein the subject posits a statement about a particular situation with intent to verify or test this presumption. The subject could be generating a hypothetical construction about the problem situation for later evaluation.*"

Experts appear to be significantly better with their hypothesis testing when compared with novices. Firstly, Schenk et al found that experts "*verbalized hypothesis testing and discarding behaviors more frequently than did novice analysts.*" Importantly, experts also discarded more hypotheses i.e. they were able to establish the truth or otherwise of their hypothesis and therefore eliminate more points of uncertainty. Novices on the other hand were left with more hypotheses (i.e. points of uncertainty) which were either later forgotten or never tested and, as a result became accepted as facts (Sutcliffe & Maiden, 1992). As Schenk et al. (1998) point out, "*Untested hypotheses that are incorporated into the requirements solution may become incorrect systems features, reflecting an incomplete or erroneous view of the user's problem*". Furthermore, "*The expert protocols often revealed a more sceptical tone or wary approach than those of novices.*" This suggests that experts are more likely to question "facts", assumptions and so on (i.e. add more hypotheses to confirm facts or assumptions) which novices might accept at face value.

In terms of the quality of the hypotheses that experts and novices generated, Sutcliffe and Maiden (1992) in a study of novice systems analysts (Master of Science students with less than 6 months analysis experience) concluded that the novices were "*poor reasoners unable to develop and test hypotheses about many requirements or problems identified in the problem narrative*" which they were asked to analyse. Those novices who had good modelling skills were able to generate better hypotheses than those with poor modelling skills. This latter point is an important one because being able to model the problem domain effectively appears to significantly facilitate the understanding of the problem domain. The ability of experts to model the problem domain effectively appears to allow then to "*reason about a problem, to create test cases and scenarios for testing hypotheses critically. On the other hand, novice information analysts can generate hypotheses only at a general level and make few attempts to test hypotheses* *because they focus only on the syntactic part of the representation*" (I. L. Huang & Burns, 2000).

The conclusion that can be drawn is that systematic and disciplined application of hypothesis testing and superior modelling skills shown by experts combine to avoid potential problems through checking of facts and assumptions and reduce complex tasks into manageable ones by reducing uncertainty.

*3.5.2.9.7 More effective goal generation*

Generating appropriate goals is a key aspect to planning and generating strategy. One difference between experts and novices is their problem decomposing strategies which then allow them to set goals towards a final solution (Ho, 2001). Vitalari and Dickson (1983) suggest that "*the use of specific goals may be an important factor in dealing with the abstract nature of analysis problems because goals impose a structure on the solution process and act as guideposts for the solver in developing a solution path*". As was expected, Schenk et al. (1998) found that novices tended to generate fewer goals than did experts and although "*novices generated more strategies than did experts, strategies without appropriate goals tend to be weak and, in the worst case, a random walk without an overall goal structure.*" This also helps to explain why novices find it difficult to focus and flounder when faced with complexity.

*3.5.2.9.8 Thinking at higher levels of abstraction and use of analogy*

Experts think at higher levels of abstraction and because of this are able to organise larger amounts of knowledge in structured ways which are useful for IS analysis. More specifically in the area of conceptual data modelling (Dinesh Batra & Davis, 1992) found that "*experts exhibit richer vocabulary and relative ability to categorize problem descriptions into standard abstractions*". In contrast, novice information analysts tend to think more concretely, store information in long term memory as concrete objects and hence do not have the overall structures which allow them access this information as usefully. Furthermore, the higher order abstractions used by experts allows them to perceive and make use of analogies to help with the current analysis (Dinesh Batra & Davis, 1992; I. L. Huang & Burns, 2000; Sutcliffe & Maiden, 1992; Vitalari & Dickson, 1983).

*3.5.2.9.9 Early focus on solution conjectures*

It was argued earlier that IS analysis should be regarded as an holistic design activity of finding effective solutions to organisational problems rather than a sequential process with design taking place after problems have been defined, goals set and requirements found (Carlsson, Hedman, & Steen, 2010a; Simsion et al., 2012; Stolterman, 1992). However, the research literature into IS analysis expertise typically has not viewed the process in this fashion and so it is worthwhile to look more widely to get some insights into a more holistic design process and hence propose differences between novices and experts in IS analysis.

Studies into expertise in areas traditionally accepted as design, e.g. architecture and engineering, can provide an insight into problem domain knowledge and finding solutions in IS analysis. In these design domains, expert designers appear to be different from other kinds of problem solvers who usually attempt to define or understand the problem fully before making solution attempts. Cross (2004) suggests that expert designers in this domain move early in the process to make conjectures about solutions. They used these conjectures to explore the problem and the solution together. The degree and type of experience of the designer is a determining factor in this solution-focused approach, "*In particular, designers with specific experience of the problem type tended to approach the design task through solution conjectures, rather than through problem analysis.*" After an initial (holistic) "breadth first" investigation of the problem domain, experts use their solution conjectures to guide further information gathering which then helps in problem definition and scoping which then informs the solution conjectures and so on in an iterative fashion. Similarly with the very complex situations found in Information Systems analysis, it seems a reasonable conjecture that the expert analyst classifies the problem into a particular type and then also considers solutions either based on their experience, knowledge or through research and hypothesizes potential solutions; thereafter the expert thinks holistically about the problem, potential solution(s), strategies and goals.

Unguided information gathering in the problem domain (which is more in keeping with the way analysis is typically described and prescribed) does not lead to better solutions. There have been a number of studies in design areas which indicate that novices, typically those in the early stages of learning design (e.g. students) can become stuck in information gathering and problem definition and never even progress to design (Cynthia J. Atman et al., 2007; Cynthia J. Atman, Cardella, Turns, & Adams, 2005; C J Atman, Chimka, & M, 1999; Christiaans & Dorst, 1992; Kolodner & Wills, 1996). Kolodner and Wills (1996), for example, in studying senior student engineering designers observed that, "*Proposed solutions often directly remind designers of issues* *to consider. The problem and solution co-evolve.*" Analysing and structuring the problem domain is not primarily about learning about the problem domain (there are application domain or knowledge area experts for this), but rather about considering the *problem-with-solution*. This process guides what information is required by the analyst. Considering solutions in the early stages of analysis is not something to be avoided; the problem is premature commitment to a solution before a holistic understanding of the problem domain and the impact of proposed solutions has been achieved.

This view of IS analysis as an activity of problem-with-solution design may be a way of explaining why experts are better at "doing" IS analysis in contrast to novices and other less competent professionals in the field. It is in keeping with the more holistic approach suggested that experts adopt when approaching problems and acts as a coordinating mechanism which shapes how they think about the problem, goals, strategies and solutions as a total package rather than as separate though linked activities.

#### 3.5.2.10 ISD Process Knowledge

##### *3.5.2.10.1 Greater user involvement over the whole project lifecycle*

Experts demonstrate strong interest with user involvement throughout the development process and concern about the amount of involvement they could expect from the user (Vitalari, 1985). Schenk et al. (1998) found that while novices verbalised the need for user involvement in the development process more so than experts, in practice this interest was confined largely to the early stages of the requirements task rather than to maintain it throughout the whole development process. This reduced involvement with users in the latter stages of a project means that users are less involved in the stages of searching for the most appropriate solutions, more detailed consideration of constraints and change management issues. The latter points relate to the quality of the final solution, user ownership and maximising the probability of the solution being accepted and used effectively within the organisation.

##### *3.5.2.10.2 Decreasing use of formal methodologies and techniques with experience*

With regard to development methodologies, less experienced developers state that they need these explicated methodologies which help them learn a company's development practices but with increasing experience this knowledge appears to become internalized and developers begin to find them increasingly limiting or in some cases (e.g. especially in situations involving software tools) inappropriate for the particular situation (Kautz, Hansen, & Jacobsen, 2004). Davies, Green, Rosemann, Indulska, and Gallo (2006) also found that modelling techniques are increasingly used with increasing years of experience until the analyst reaches a level that they described as reaching expert status after which the level of usage of modelling techniques decreases significantly. More precisely they found that, "*There is a significant increase in usage of modelling techniques from the 0 to 3 years level to the 4–10 years level of modeler experience. From that point however, we see a significant decrease in technique usage as practitioners move into the 11–20 years of modeling experience level. Indeed this trend continues into the greater than 20 years of experience level.*" Following on from Kautz et al, this suggests that the most experienced practitioners use their internalised methodologies and techniques and domain knowledge instead of the prescribed methods and do not go through formal step by step guides. An interesting point to consider is that methodologies, techniques and software tools have improved over time and the argument could be raised that much more experienced (and older) analysts have had very reasonable responses to the less flexible methodologies, techniques and certainly far less sophisticated software tools of the past. Hence, these "snap shots" at particular points in time of the analysts across the various demographics of experience may to some unknown extent reflect historical circumstance.

###### *3.5.2.10.3 Requirements analysis*

Hickey et al (Hickey & Davis, 2003) made a number of observations about expert analysts in the requirements analysis process. Firstly, experts perceived requirements analysis as an iterative process rather than as a one-off or sequential process. They also thought holistically in that they were aware of the "*specific situational characteristics operating at the time and their actions were determined by this*". They were aware of the advantages and disadvantages of various requirements analysis techniques, their underlying assumptions and when they could be most appropriately applied. While experts had their favourite techniques they were prepared to use other techniques if they believed them to be more appropriate in a particular situation. Furthermore, with increasing years of experience, experts learned and applied an increasing number of techniques. In contrast Hickey and Davis (2003) stated that most practicing analysts (but not experts) were limited in their choice of elicitation techniques and didn't have sufficient insight to be able to make the finer grain distinctions to choose between techniques.

One significant area of difference in terms of expertise was in terms of holistic understanding of the problem domain found between high ranked analysts as compared to low ranked analysts (ranked by superiors and peers). High ranked analysts took a broader perspective on information requirements compared to low ranked analysts e.g. low ranked analysts concentrated on tasks, processes, information flows and storage while high ranked analysts considered non-functional requirements such as the "*nature of the job, interjob relationships, and context in which the job is performed*" (Vitalari, 1985). Hickey and Davis (2004) suggest that the characteristics of the problem domain, the solution domain and the project domain affect the choice of elicitation techniques. Some of the factors to consider include the state of the requirements at the time (i.e. what is already known), particular knowledge known by and characteristics of the people from whom requirements are to be elicited (e.g. levels of literacy, IT knowledge, tacit knowledge etc.), clarity of requirements and emotional and social factors (e.g. level of trust, power relationships etc.). Within the project domain the choice of elicitation techniques can influence or be influenced by the methodology to be used. However, experts do not consciously go through a process of considering all the potential factors (Hickey & Davis, 2003) but instead scanned the situation for a small set of major drivers to select a particular technique and inhibitors to avoid a particular technique. This latter point is in keeping with the point made earlier that experience helps to identify the key issues and by concentrating effort on those issues leads to a more effective process and outcome. This point is also in keeping with expert analysts having problem-solution conjectures which guide them in deciding what might be key issues. One very common requirements elicitation technique is interviewing. (A. Davis, Dieste, Hickey, Juristo, & Moreno, 2006) reviewed the IS literature on the requirements elicitation techniques comparing the effectiveness of structured interviewing against unstructured interviewing and comparing novices with experienced analysts. The relevant papers reviewed in this regard were by Marakas and Elam (1998), Agarwal and Tanniru (1990), Pitts and Browne (2004) and Fowlkes, Salas, Baker, Cannon-Bowers, and Stout (2000)). A. Davis et al. (2006) came to the conclusion that "*analyst experience is not a relevant factor during information acquisition … The empirical studies show, in fact, that the careful preparation of interviews has a much more marked effect than analyst experience. In other words, a novice analyst who prepares the interview well beforehand is even capable of eliciting more information than an experienced analyst. This result is really surprising*". However, looking a little deeper into the paper by Marakas and Elam (1998) from the perspective of expertise, their results contain an interesting result. The high scoring participants who participated in the requirements elicitation experiment consisted of those who were asked to apply the particular model of inquiry but it also contained several high scoring participants in the experienced control group who were not exposed to that model. These high scoring experienced analysts were found to have used "*a similar questioning pattern*" to the model of inquiry. One way to interpret this is that amongst the experienced analysts some clearly learned, either through training or experience, an effective model of inquiry which they naturally use. This appears to reinforce the lesson that adopting more effective techniques is the key to better results and on the path toward developing expertise.

Requirements gathering is a time consuming activity and analysts must typically balance between the limited time available and having gathered requirements such that they can safely proceed with the project. Pitts and Browne (2004) studied the stopping behaviour of experienced analysts in requirements gathering to determine which strategies were most used by analysts to determine when they could stop the requirements gathering process. All analysts had at least two years' experience (average 11 years) and Pitts and Browne differentiated between experienced analysts and novices (in this case those with only a few years' experience) to compare stopping behaviour. Their results show a significant difference between more experienced analysts and less experienced analysts in that more experienced analysts used mental lists based on past experience and familiarity with the problem domain and a magnitude threshold strategy such that the analyst stopped when they believed had acquired sufficient information. On the other hand less experienced analysts were more likely to use an incremental approach to gathering information so that they either gathered more and more from stakeholders until no more new information was being acquired (difference strategy) or they created a user interface design which they presented to users which was modified in an incremental manner based on their feedback until it too was no longer being modified (representational stability strategy). All strategies took similar amounts of time and the most effective strategies in terms of the quantity of requirements gathered were the mental list strategy and the difference strategy with virtually the same quantity of requirements gathered. The requirements gathered by analysts were not different in terms of breadth but were significantly different in terms of depth. While quantity of requirements gathered is one measure for comparing analysts, the authors did not mention any attempt to measure the "quality" of requirements gathered. Based on quantity alone, these results are consistent with the idea that experience is not a good determinant of expertise since some novices could perform as well as some more experienced analysts but it is also consistent with the idea that more experienced analysts used past experiences to structure their thinking and to aid them in requirements gathering. A later article by Pitts and Browne (2007) with the same group of participants demonstrated that different questioning style using procedural prompts (focusing more on system goals, outputs and procedures) was significantly more effective in eliciting requirements than an interrogatories prompts (who, what, when and how type questions). However, this later study did not make any connection between this result and years of experience or expertise. Some analysts cited the usefulness of templates of requirements categories as means of ensuring that all requirements categories were covered but Hickey and Davis (2003) did not report on the particular analysts who mentioned them.

*3.5.2.10.4 Conceptual modelling*

Hickey and Davis (2003) stated that modelling was widely regarded as critical in all situations of requirements analysis stating that "*more and more analysts are now seeing modeling as a means to (a) facilitate communication, (b) uncover missing information, (c) organize information gathered from other elicitation techniques, and (d) uncover inconsistencies.*" I. L. Huang and Burns (2000) identified "*at least four characteristics of modeling behaviors differentiating expert from novice information analysts: model-based reasoning, mental simulation, critical testing of hypotheses, and analogical domain knowledge reuse.*" They suggested that experts have a richer semantic knowledge compared to novices which allows them to apply more appropriate modelling principles, perform more critical testing of hypotheses, and finally achieve better quality requirement specifications. The procedural aspect of a requirements analysis technique (how to perform the process) is more difficult to learn than the declarative aspect (representing aspects of the domain) but the procedural aspect of modelling knowledge is more important in determining the quality of requirement specifications (Vessey & Conger, 1993).

I. L. Huang and Burns (2000) suggested that during information requirement analysis, expert information analysts use requirements analysis techniques for mental simulation of information requirements while novice analysts used requirement analysis techniques only for representation (Adelson & Soloway, 1985). Mental simulation mentioned in this context refers to the cognitive processes of building a mental model that establishes connections among the parts of the system under investigation and of using the mental model to reason about the interactions among the parts of the system (Adelson & Soloway, 1985; Curtis et al., 1988; Raymonde Guindon, 1990; R. Guindon & Curtis, 1988). Mental simulation makes expert analysts focus on the semantic part of the problem statement. Without mental simulation novice information analysts can analyse only the syntactic part of the representation (Adelson & Soloway, 1985; Allwood, 1986). I. L. Huang and Burns (2000) suggested that due to the differences in knowledge, novice and expert information analysts use different types of cognitive processes e.g. relation mapping by experts versus object-attribute mapping by novices, to model information requirements. The different cognitive processes lead to different modelling behaviours, and in turn the different modelling behaviours finally result in different qualities of requirement specifications. Sutcliffe and Maiden (1992) concluded that major determinants of novice analyst success appeared to be the ability to reason critically and to reason effectively with conceptual models.

There are some significant differences between experts and novices in terms of what they regarded as more or less important to focus on within the problem domain. For example, Sutcliffe and Maiden (1992), in studying the modelling behaviours of novice information analysts using Data flow Diagrams found that novice information analysts were more successful at recognizing system goals and inputs compared to system data stores, processes, and outputs. Schenk et al. (1998) found that experts focused on the outputs of the system and on database requirements. In contrast, novices were more concerned with specific issues such as inputs and processes and very general issues such as development issues and purpose of the system and, in fact, tended to jump from the specific issues to very general issues. Schenk et al. (1998) described these differences between novices and experts as “critical”. An interesting finding by Schenk et al. (1998) was the strong correlation between the importance placed on database requirements by analysts and the increased perceived skill level of the analysts.

*3.5.2.10.5 Data modelling*

In several studies of differences between expert and novice conceptual data modellers it was consistently found that the data models produced by the expert data modellers were significantly superior to those produced by novices (Dinesh Batra & Davis, 1992; McGinnes, 2000; Shanks, 1997; Venable, 1995). Dinesh Batra and Davis (1992) studied the conceptual models developed by novices (undergraduates and recent graduates with little experience) compared to more experienced analysts with several years' experience. They found that these novices tended to have more errors in their conceptual models compared to experts largely due to their inability to map parts of the problem description to appropriate knowledge structures as well as the failure to integrate pieces of information. Others have also found that novices struggle to think at a metacognitive level and to understand such abstract concepts (Chilton et al., 2006; Hadjerrouit, 1999; Yazici et al., 2001). Venable (1995), studying undergraduate students, concluded that these novices (1) lacked the experience which would allow then to fully understand the problem domain, (2) lacked appropriate problem solving heuristics, (3) didn't fully understand the modelling constructs, (4) worked at too low level of detail, (5) had a poor ability to review the quality of their model and (6) had a poor ability or willingness to review the quality of their understanding of the problem domain.

McGinnes (2000) conducted a field study with 10 participants consisting of one IT modelling expert and nine other people working in industry (apart from one 4th year computer science student) and required them to develop conceptual data models across many different domains. This group of novices had significant understanding of business or organisations and were willing to try to understand the problem domain. McGinnes' study confirmed Venable's earlier study of novice difficulties and found also that novices:

- had particular difficulty modelling relationships, many of which were redundant in the context of other relationships in the model
- struggled to think analytically in a consistent manner while experts were able to switch between intuitive (creative) and analytical modes at will
- struggled with the idea of a conceptual model as a series of logical propositions
- tried to read their model as if its meaning could be stated in a single sentence and that this was one reason why they misinterpreted their diagrams.

The particular conceptual data model used by novices appears to be critical to the quality of their result but this is not the case with an expert analyst. In his field study, McGinnes (2000) developed a conceptual data modelling technique with a software tool supporting it called Business Concept Modeling (BCM) for use by novices and the expert analyst with their users. BCM was designed to be more intuitive, pictorial and provided prompts for potential categories of information. The BCM models developed by novices achieved high levels of accuracy and completeness (80% on his measures) although the expert participant who achieved near 100% levels. When the same novices tried to use the more formal object conceptual model the models developed were declared to be largely unusable; in comparison the expert still achieved near 100% success. The expert was able to translate users' concepts to the more formal and abstract representation required by the object model. McGinnes concluded that users' and novices' understanding of the model and their feedback on errors were key factors in the improved novices' performance. The lesson here appears to be that the type of technique(s) used can dramatically improve novice analyst performance with regard to requirements elicitation.

Shanks (1997) study on data modelling skill used only experienced data modellers with varying years of experience and found that experts tended to use higher levels of abstraction to attain greater flexibility suggesting that this is an increasing skill with expertise. The novices were classified as analysts who had already developed up to nine data models in practice and had an average of 1.5 years' experience. In comparison, experts in this study had developed 10 or more data models and had an average of 6.4 years of experience. He found the experts' models to be "*more correct, complete, innovative, flexible and better understood than those built by novices*" with the greatest differences in the areas of completeness, innovation, flexibility and naming of relationships.

## 3.6 Levels of IS Analysis Expertise

In this section the Five Stage Model of Skill Acquisition (S. E. Dreyfus & Dreyfus, 1980) is used to describe the development of an individual from novice stage to expert stage. This model was originally proposed by Dreyfus and Dreyfus (S. E. Dreyfus & Dreyfus, 1980) and later summarised in S. E. Dreyfus (2004). The levels proposed by Dreyfus are novice, advanced beginner, competent, proficient and expert. The description uses the term "levels" but development from novice to expert is clearly more like a continuum and it not suggested here that there are obvious "jumps" from one level of thinking to the next. Its justification is that it provides a useful framework from which to view the knowledge and skill development from novice to expert in IS analysis. Furthermore, while an individual might be classified at a particular level such as “proficient” that does not necessarily imply the individual is equally proficient in every area of knowledge and skill.

The description below assumes a particular path toward the development of IS analysis expertise based around the assumption that an individual undertakes an IS oriented academic program in higher education then works as an IS analyst. Such a path assumes learning takes place at the early stages largely through academic instruction and later largely through experience. This is consistent with the assumptions of the Five Stage model. However, Information Systems is an area in which practitioners come from a variety of backgrounds and individuals may well develop expertise in a variety of ways which might include coming from a technical IT degree, a business degree or a degree from an unrelated area of academic study (e.g. philosophy or science) or have little in the way of formal qualifications and have “worked their way up”. These are other paths to IS analysis expertise and not necessarily as relevant here.

In describing IS analysis expertise development below, there is a significant deviation from the standard description provided by the Five Stage model which relates to holistic understanding and this occurs most predominantly in the Expertise stage. In this stage the model suggests that the expert operates entirely through perceiving the situation immediately and operating intuitively so as to know what to do next. In the areas that Dreyfus typically uses as examples of development of expertise, e.g. chess and piloting an aircraft, this idea of an expert appears to be reasonable because in a game of chess or an aircraft cockpit all the relevant information is immediately available and visible to the individual. With regard to IS analysis, however, “instant” and intuitive recognition of a solution is simply not possible since it takes significant time and effort to gather information, explore the issues, develop models, consider possible alternative solutions and so on. Others have similarly criticised the Five Stage model (Cader, Campbell, & Watson, 2005; Gobet, 1997; Klein, 1998; Prietula & Simon, 1989) suggesting that in many domains decision making uses a combination of intuition to rapidly perceive a situation and make judgments and slower analysis and problem solving depending on how well-structured or ill-structured is the task. Application of the Dreyfus model to development of expertise in the area of clinical medicine is a case in point (Carraccio, Benson, Nixon, & Derstine, 2008; Peña, 2010; Rikers, Schmidt, & Boshuizen, 2002). This criticism applies in regards to the more technical aspects of IS analysis but the task is made perhaps more complex because of the need for extensive information sharing and negotiation amongst the stakeholders and the social and political factors involved.

Finally, while acknowledging that the IS analysis expert has a great deal of intuitive knowledge that they use regularly, the IS analyst often has the burden of having to provide reasoned justifications of their judgments explicitly via discussions, presentations and reports.

## 3.6.1 Five Stage Model of Skill Acquisition for IS analysis expertise

In the following sections a brief description of each level of the Dreyfus model is provided followed by a description of the elements which apply to that level with respect to IS analysis. At the lowest three levels a rough estimate is made of how long a motivated learner might stay in that level before moving on to the next stage with appropriate teaching, coaching and resources. There is no attempt to put a timeframe on the proficiency stage since evidence suggests that this is highly variable and many individuals do not ever progress to the expert stage.

## 3.6.2 Novice

In the novice stage *"the instruction process begins with the instructor decomposing the task environment into context-free features that the beginner can recognize without the desired skill. The beginner is then given rules for determining actions on the basis of these features, just like a computer following a program"* (S. E. Dreyfus, 2004)

The interpretation here is that this corresponds to the early stages of an IS Bachelor's degree program.

It is assumed that the novice has little or no experience in business or IT and is enrolled in an analysis focused IS degree developed under the guidelines such as proposed by Topi, Valacich, Wright, Kaiser, Nunamaker Jr., et al. (2010). At this stage, presenting problems within real world settings is difficult because of novices' lack of knowledge. They learn basic concepts e.g. in IS based analysis areas these would be within topics such as data modelling, process modelling et cetera or systems development methodologies and they gain experience of them through situations presented for discussion, practice exercises and small scale problems to be solved but largely protected from direct, practical experience of real world settings. The novices' task is to try to grasp the meaning of the concepts and to understand and apply principles, methods and rules correctly. This is a well-recognised area of difficulty (Armarego, 2002; Connolly & Begg, 2006; DeGrace & Stahl, 1990; Fitzgerald, 1998; Ge & Land, 2003; Schenk et al., 1998). It is worth mentioning that the learning process also involves "unlearning" as learners replace their existing mental models (of business, IT systems, organisations etc.) that they will have acquired with ones that are more realistic or more effective e.g. (Cope, 2002, 2003).

### 3.6.3 Advanced Beginner

In the advanced beginner stage, *"the novice gains experience actually coping with real situations and begins to develop an understanding of the relevant context, he or she begins to note, or an instructor points out, perspicuous examples of meaningful additional aspects of the situation or domain. After seeing a sufficient number of examples, the student learns to recognize these new aspects. Instructional maxims can then refer to these new situational aspects, recognized on the basis of experience, as well as to the objectively defined nonsituational features recognizable by the novice. … at this stage, learning can be carried on in a detached, analytic frame of mind, as the student follows instructions and is given examples "(S. E. Dreyfus, 2004)*

The interpretation here is that this corresponds to the later stages of IS degree majoring in the analysis area.

Schenk et al. (1998) found that novices (note that these were students with extensive academic training doing an MBA with an IS major but with less than 6 months experience) had more difficulty with the problem-solving process than experts in terms of recognising the existence of a problem, defining the correct problem, using the available information, recognising or questioning assumptions, considering a wide range of alternatives and addressing implementation issues. Others have noted that novices have difficulty with problems in which there no single, simple, well known or "correct" solution (Connolly & Begg, 2006; DeGrace & Stahl, 1990; Fitzgerald, 1998). When it came to finding solutions, Vitalari (1985) found that novices did not show enough concern for the effect of constraints on potential solutions.

Dreyfus suggests that the learning in this stage can be mentally exhausting for the novice but is guided and mediated by teaching staff (and possibly industry mentors when available) who find suitable situations and problems within the capabilities of the advanced beginner and then provide support and guidance as appropriate when they encounter difficulties or they are observed to be making inappropriate decisions or simply "stuck" in some way.

### 3.6.4 Competency

"*With more experience, the number of potentially relevant elements and procedures that the learner is able to recognize and follow becomes overwhelming. At this point, because a sense of what is important in any particular situation is missing, performance becomes nerve-wracking and exhausting, and the student might well wonder how anybody ever masters the skill.*" (S. E. Dreyfus, 2004)

In this stage, individuals organise themselves around hierarchical long range plans and their efficiency improves but the planning is conscious, deliberate, analytical and abstract. Situations are not perceived in a holistic way although they can appreciate the interconnectedness of things from a logical and analytical perspective.

The interpretation made here is that this level begins when the individual begins working in the role of an IS analyst in real world situations. It includes Industry Based Learning or capstone projects based around real world projects which might be incorporated in undergraduate studies. The difficulty for those entering this next stage is how to go about the problem solving process in real world projects (Armarego, 2002; Connolly & Begg, 2006; DeGrace & Stahl, 1990; Fitzgerald, 1998; I.-L. Huang, 2009; I. L. Huang & Burns, 2000; Kleeman, 2005; Schenk et al., 1998; Stolterman, 1992).

The learner begins to appreciate the complexity of the organisation and the interconnectedness of people, processes, management, and technology and so on. In real world situations, the complexity of and subtle differences between situations is such that it is not possible to prepare the learner for all the eventualities, precisely what to look for and what actions to take. Dreyfus suggests that in this stage the learner must make decisions which affect the outcomes of projects to which they have been assigned. When involved in analysis, writing a report, developing a model etc. making mistakes, inadequate analysis, making or accepting unwarranted assumptions, not fully understanding the rules or requirements now have potentially serious consequences for which the learner has some responsibility.

Davies et al. (2006) found significantly increasing use of tools and techniques in IS analysis from 0 to 3 years of experience but thereafter usage remains fairly steady. This suggests that something like 3 years' experience is typically required for novices to learn and develop their competency in applying a variety of tools, techniques, approaches etc. and simply becoming familiar with the tasks involved.

In this stage the learner develops knowledge and skills on the smaller scale (e.g. interviewing, requirements elicitation, modelling techniques etc.). However, within this stage the learners' still fragmented knowledge means that in trying to understand a problem that they do not think broadly enough and they miss features (Schenk et al., 1998). They tend to approach problems from the bottom up rather than top down (Mackay & Elam, 1992, p. 151) and tend to focus on surface characteristics (Sutcliffe & Maiden, 1992). While they consider a variety of problem solving strategies these strategies tend to be relatively general in nature and less effective compared to those at higher levels of expertise. They lack a comprehensive plan and their goal generation is relatively poor. Their lack of experience in problem solving and design may cause them to become stuck in analysis or prematurely decide on a solution. They do not adequately test assumptions or requirements which lead to errors or which fail to reduce complexity (Sutcliffe & Maiden, 1992).

Another aspect of this stage according to the Dreyfus model is that the learner must become engaged emotionally, take responsibility for successful and unsuccessful choices, "*replay one's performance in one's mind step by step*", and to let the mistakes and insights sink in. If the learner accepts responsibility they will experience emotions of fear and elation which they did not experience in the earlier stages. The Dreyfus model suggests that what sets up the learner for movement into the next stage is the positive and negative experiences from the this stage which "*strengthen successful perspectives and inhibit unsuccessful ones, and the performer's theory of the skill, as represented by rules and principles, will gradually be replaced by situational discriminations.*"

### 3.6.5 Proficiency

"*The performer acquires the ability to discriminate among a variety of situations, each entered into with involvement, plans are evoked, and certain aspects stand out as important without the learner standing back and choosing those plans or deciding to adopt that perspective*" (S. E. Dreyfus, 2004).

The complexity of problems in organisations is well summed up by Ackoff (1979), "*Managers are not confronted with problems that are independent of each other, but with dynamic situations that consists of complex systems of changing problems that interact with each other. I call such situations messes. Problems are abstractions extracted from messes by analysis*". At this stage the Dreyfus model suggests that the learner's analysis skill is such that they are able to see into "the mess" and find suitable abstractions from an information systems analysis perspective so that they understand the salient points in a situation. However, he suggests that at this stage the learner has not developed sufficient experience of the outcomes of decisions to be able to see intuitively the actions to do next and falls back on rules and maxims which apply in different situations i.e. they rely on analytical thinking to choose actions.

In this stage, if given the opportunity and if the learner stays emotionally involved and reflective, the learner develops their repertoire of experience across the knowledge and skill areas and in particular their experience in problem solving, problem domain knowledge and IS process knowledge. In this stage learners develop their understanding of the practical implications of particular Information Systems knowledge and also develop knowledge which is "*condensed and packaged in an action oriented way so that IS practitioners find it helpful in their work*" (Iivari et al., 2001). This "*action oriented way"* of working guides the analyst as to how to start the project or an activity, determine achievable goals, understand and scan for the key events or information that are important for an activity, the steps or activity one should undertake next, knowing when has acquired enough information, when one can stop an activity, and so on.

### 3.6.6 Expertise

"*The expert not only sees what needs to be achieved; thanks to his or her vast repertoire of situational discriminations, he or she also sees immediately how to achieve this goal. Thus, the ability to make more subtle and refined discriminations is what distinguishes the expert from the proficient performer. Among many situations, all seen as similar with respect to plan or perspective, the expert has learned to distinguish those situations requiring one reaction from those demanding another. That is, with enough experience in a variety of situations, all seen from the same perspective but requiring different tactical decisions, the brain of the expert gradually decomposes this class of situations into subclasses, each of which requires a specific response.*" (S. E. Dreyfus, 2004)

IS analysis is complex and open ended because of the breadth of issues that must be considered and the varying and evolving nature of nearly all aspects which are involved (i.e. technology, organisations, business, IS process knowledge, problem domain etc.). In IS analysis, expert intuition appears to manifest through being able to select a reduced set of appropriate and more effective strategies compared to novices across different situations. This means that experts are not cognitively working any harder just more effectively (Schenk et al., 1998).

Experts have acquired substantial knowledge and have had extensive and varied experience to develop their business, organisational, technical, IS applications knowledge and skills essentially filling in the gaps in knowledge and skills which are observed at lower levels of expertise (Atwood et al., 1979; D. Batra & Davis, 1989; Sutcliffe & Maiden, 1992). IS analysis experts think holistically. This is consistent with Hager's (Hager, 2000) four holistic aspects of practical judgment which takes into account specific features of the environment, social and political norms and values prevalent, personal characteristics of those involved. Experts' holistic approach and broader and deeper knowledge makes them aware of more factors that need to be taken into consideration and so they may well take longer to understand and comprehend the dimensions of a problem situation than those who are less expert. However, they intuitively focus on key issues and intuitively select more appropriate strategies for dealing with a situation (Cynthia J. Atman et al., 2007; Cynthia J. Atman et al., 2005; D. Batra & Davis, 1989; Schenk et al., 1998). They more actively and effectively use hypothesis testing to reduce uncertainty and check assumptions and facts (Schenk et al., 1998).

If we accept that ISAD analysis, as described here, is actually a design process then the research literature from design areas suggests that expert IS analysts explore the problem situation by making early solution conjectures as a means of exploring the problem and help the expert to avoid becoming stuck in analysis (Cynthia J. Atman et al., 2007; C J Atman et al., 1999; Christiaans & Dorst, 1992; Cross, 2004; Kolodner & Wills, 1996). This means that experts are thinking about the situation holistically but this time from a "problem to solution" perspective. In this style of thinking their greater knowledge and experience with IS applications and technology allows them to be better able to see the implications of design decisions on the required business behaviour (Curtis et al., 1988). Combining this with experts' deeper and broader knowledge and experience regarding strategies, it not surprising that experts select fewer and better strategies which are more detailed and that they are better able set goals (Schenk et al., 1998) and may even be regarded as visionary (Curtis et al., 1988).

Experts demonstrate substantial interpersonal skills whether they are working in teams or leading them (Vitalari, 1985; Wynekoop & Walz, 2000) and are excellent communicators (Curtis et al., 1988; Khan & Kukalis, 1990).

Personal attitudes and capacities displayed by experts were that they were dependable, motivated (even passionate), organised, creative, disciplined and liked challenge and autonomy and tended to work hard (Curtis et al., 1988; Smits et al., 1993; Stolterman, 1992; Wynekoop & Walz, 2000). In terms of critical thinking, experts are logical and analytical and able to integrate knowledge areas. Experts are able to think more abstractly than non-experts, move easily between levels of abstraction and make use of analogy.

## 3.7 Chapter Summary

This chapter began by discussing the purpose and scope of activities and processes involved in IS analysis and design. It briefly reviewed the models suggested as describing the analyst problem solving process and argued that real world problem solving is more chaotic and iterative than often portrayed. It was suggested that the field of strategic decision making provided a better basis for describing the problem solving process. From that basis a more realistic model for IS analysis and design was developed by this researcher described as the ISAPS (Information Systems Analysis Problem Solving) model.

The knowledge and skills required by IS analysts was reviewed based on an examination and analysis of recent recruitment surveys for IS analysts or similar positions. This resulted in a comprehensive taxonomy of knowledge and skills for IS analysts. The knowledge and skills characterising and differentiating of IS analysts from other business and IT professionals working in the same space were presented.

A detailed review and summary of the literature on IS/IT expertise was conducted which highlighted the differences between novices and experts but also described the limitations of this research. Finally, using the novice-expert differences determined from the literature survey, the Dreyfus Five Stage Model of Skill Acquisition was used as the basis to develop a new five stage model specialised for IS analysis expertise.

The next chapter deals with the research methodology used to address the original research questions. The particular area of interest of this research lies at the beginnings of the Competency stage of the specialised IS analysis Dreyfus model. The chapter describes the concept of capstone projects as vehicles to introduce students to real world practice with real clients. The projects within the scope of this research were conducted in a supportive learning environment the key feature of which was having expert analysts from industry acting as coaches and mentors to students to aid in the development of students' expertise.

# 4 RESEARCH DESIGN AND METHODOLOGY

## 4.1 Introduction

This chapter describes the philosophical position taken and methodology used in order to answer the research question

*How can the professional judgment of final year Information Systems students be improved to better deal with Information Systems analysis and design projects that involve real world problems and clients?*

As will be justified later a qualitative approach was taken to this research. Qualitative research involves exploring complex social phenomena which people experience for the purpose of gaining a deeper and more meaningful understanding of those social phenomena.

Qualitative research paradigms are numerous and involve a variety of ontological, epistemological and methodological assumptions (Guba & Lincoln, 1994; Spencer, Ritchie, Lewis, & Dillon, 2003). These differing and competing paradigms result in research communities in which "*the background beliefs and assumptions of different communities affect what they accept as legitimating evidence and sound reasoning*" (Guba & Lincoln, 1994; Polkinghorne, 2007). It therefore becomes necessary for the researcher to establish those assumptions and make them clear to the reader so that the reader understands the particular perspective taken by the researcher. In doing so the reader is provided the context in which to understand what was done and why it was conducted in a particular fashion (Braun & Clark, 2006). Stating these assumptions also helps the reader to understand the results of the research, why they are presented as they are and to make an informed judgment as to its correctness and value. Accordingly, the assumptions made within this particular research study are stated in the first part of this chapter by outlining the epistemological position taken, the research design and explaining why a qualitative content analysis methodology was adopted.

Rigour in research is characterized by the qualities of validity and reliability. Validity is concerned with whether the research investigates what it is supposed to (internal validity) and the extent to which the findings can be transferred to other contexts (external validity). Reliability, on the other hand, relates to whether appropriate methods were used and the care with which they were applied (Guba & Lincoln, 1994). However, these terms carry a certain amount of "baggage" in that they are terms emerging from a positivist research paradigm (exemplified by the physical sciences) and it is argued that qualitative research should be judged on qualities more appropriate to the aims and situations which characterize qualitative research (Lincoln & Guba, 1985) .

Lincoln and Guba (1985) used the term *trustworthiness* as an overarching term encompassing a set of evaluation criteria that they proposed for judging the quality of qualitative research. They initially proposed four guidelines for qualitative research: *credibility* which relates to confidence in the truth of the findings; *dependability* which refers to the stability of the data over time and varying conditions; *confirmability* which refers to the objectivity displayed by the researchers and *transferability* which refers to possibility of extrapolating or using the results of the research in other contexts. Guba and Lincoln later added *authenticity* to their guidelines (Guba & Lincoln, 1994; Lincoln & Guba, 1989). This latter guideline refers to the extent to which researchers fairly and faithfully) represented the research participants' perceptions. This later guideline was added so as to be consistent with the constructivist paradigm that posits that each person has their own personal and unique world view. Throughout the remainder of this chapter, the trustworthiness guidelines described above relating to judging the quality of qualitative research will be addressed according to their relevance within each section.

The next section discusses the epistemological position taken. The overall research design adopted to address the research question is then discussed. The educational environment in which projects were conducted is then described in some detail. The data collection methods and analysis processes form the final sections of this chapter.

## 4.2 Epistemological position

### 4.2.1 Introduction

Epistemology is a philosophical theory of knowledge which can be described as "*a way of understanding and explaining how we know what we know*" (Crotty, 1998, p. 3). From a philosophical perspective epistemologies can be categorised into the three broad areas of objectivism, subjectivism and constructivism (Crotty, 1998).

### 4.2.2 Objectivism

Objectivism assumes that there is a world of objects that we perceive and that there is an intrinsic meaningful reality to them. Understanding the external world is a process of "discovery" of this meaningful reality. Meaning exists in the external world whether there is an observer or not.

The Western science and the scientific method epitomize the objectivist view of knowledge (Crotty, 1998, p. 42). In the scientific method, theories which aim to explain the world are developed, predictions are made about the behaviour of the world are made, experiments are conducted to confirm or deny the predicted behaviour and the results of these experiments hence prove, modify or disprove the theory. The objectivist viewpoint tends to take the view that its 'world view' is the way things are.

### 4.2.3 Subjectivism

Subjectivism[8] takes the perspective that meaning is imposed on objects in the external world. This meaning comes from "*primordial archetypes in our collective unconscious or dreams or religious beliefs and so on but not from the object itself*" (Crotty, 1998). Individuals view the world from internal mental frameworks, which are developed and modified over time (Bruning, Schraw, & Ronning, 1999, p. 216). Knowledge is developed through the cognitive activity of abstraction. Knowledge is constructed through the development of more sophisticated cognitive structures based on earlier

[8] Sometimes described as endogenous constructivism

structures. In this viewpoint, the external world acts as a trigger to the mind in developing its cognitive structures but it is not the source of meaning.

### 4.2.4 Constructivism

Crotty (1998, p. 42) describes constructionism[9] as the view that "*all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in an out of interaction between human beings and their world, and developed and transmitted within an essentially social context.*"

Constructivism takes the view that the external world has no intrinsic meaning so it cannot be "discovered" in the sense of objectivism. Neither is it solely the construct of the mind as subjectivism would see it. Instead it is interplay between both the external world and the observer.

In trying to make meaning of the external world an individual does not come to it with a "clean slate". An individual is born into a social world and inherits a social world of meaning through interacting with others, through cultural artefacts and institutions and particularly through language. The individual internalises these interactions and this allows us them to function by directing their behaviour and organising their experiences (Bruning et al., 1999; Crotty, 1998, p. 57; L. Vygotsky, Hanfmann, & Vakar, 2012). This inherited social world of meaning is also like a lens which focuses the individuals view as to what is seen and what meaning is made of what is perceived but, at the same time, this same lens also acts as a filter since there will be things we do not see and has no meaning for us.[10] It transforms mental functioning rather than just facilitating development that might have developed in any case.

At a personal level what drives the knowledge process is the mental contradictions that result when the individual interacts with the external world (Schunk, 2004, pp. 228-229). An individual holds a particular understanding of the world, he finds that his understanding does not sufficiently explain what he perceives and so a mental contradiction is perceived which the individual tries to resolve. Through the process of imagination and creativity a new understanding is created which resolves the mental contradiction. Constructivism is a widely used paradigm in educational research (see for example (Ben-Ari, 1998; Creswell, 2013; Larochelle, Bednarz, & Garrison, 1998; Magoon, 1977; Tobin, 1993; Von Glasersfeld, 1989).

[9] Sometimes described as dialectical constructivism

[10] This social view is sometimes termed social contructivism.

## 4.3 Addressing the research questions

The research question reiterated in the introduction to this chapter related to the improvement of the professional judgment of final year Information Systems students. In order to focus and scope the project, this broad question was broken down into the following sub-questions:

- What aspects of professional judgment in ISAD do final year Information Systems students demonstrate difficulty or gaps in their knowledge and skills when dealing with Information Systems analysis and design projects based on students' reports and the observations of their expert supervisors?
- How do the difficulties or gaps in knowledge and skills of students determined as a result of this research compare with the literature on novice-expert differences in ISAD and educational literature on students studying ISAD?
- What recommendations can be made which could enhance Information Systems students' professional judgment and development in ISAD?

It was unclear where gaps in professional judgment would appear and the nature of the gaps. The aim was to develop a real understanding and insight into the professional judgment of students by comparing it to that of the expert supervisors. It was deemed that the most effective approach to determine those gaps was to ask students and the expert supervisors about their perceptions in a holistic exploratory study. Consequently a qualitative approach was deemed to be the most appropriate manner to address the research question.

Comparing students' current abilities with those of expert analysts addressed the first sub-question which was proposed i.e. what are difficulties or gaps in students' knowledge, skills or attitudes. This was approached in two parts, which were conducted in parallel. The first part was accomplished by obtaining empirical data from students themselves as to their perceived areas of understanding and difficulties. However, students' perceptions alone do not necessarily present an entirely sound basis for assessing students' current level of professional judgment as students may misunderstand their strengths and weaknesses and there may be areas about which they may be completely unaware. The second and complementary part was to obtain the perspective of supervisors. Because of their professional expertise and because they were working closely with students they were able to provide their own assessments as to the areas of professional judgment which they believed students needed to improve. This approach provides *credibility* to any findings.

Once the data from students and their professional supervisors had been collected and analysed there was the opportunity to compare these empirical findings with the academic literature on novice-expert differences is ISAD. This addressed the second sub-question.

Finally, to address the third sub-question on recommendations for improvement required a combination of analysis and judgment on the part of the researcher informed by input from the expert supervisors, other colleagues also involved in final year student projects and ideas from academic literature based on the experiences of others who have conducted similar project based work. This addressed the third sub-question of recommendations for improvement.

## 4.4 Qualitative content analysis

There are several definitions of qualitative content analysis (Zhang & Wildemuth, 2009) but the one chosen as most apt here is the one suggested by Hsieh and Shannon (2005), "*a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns*". The process involved in qualitative context analysis is to take large amounts of text data and try to interpret and understand the data "*with attention to the content or contextual meaning of the text*" (Hsieh & Shannon, 2005) and reduce it to a number of categories or concepts (which is the term that will be used here) which represent the same meaning. "*The aim is to attain a condensed and broad description of the phenomenon, and the outcome of the analysis is concepts or categories describing the phenomenon. Usually the purpose of those concepts or categories is to build up a model, conceptual system, conceptual map or categories*" (Elo & Kyngäs, 2008).

Given the broad span of this research involving student journals, supervisor interviews and then comparing and contrasting the results, qualitative content analysis was seen as the most appropriate methodology because of its flexibility. Other qualitative methodologies were less appropriate possibly because they did not match the context of the study (e.g. action research, case study), the analysis approach (e.g. grounded theory) or the nature of the results that were intended to be obtained (e.g. thematic analysis, phenomenography).

Hsieh and Shannon (2005) suggest two approaches to qualitative content analysis relevant to this study namely, conventional (or inductive) and directed (or deductive). The deductive approach assumes that there is a significant amount of prior knowledge and that categories can be predetermined. In a pure deductive approach, one would decide categories in advance, gather data and then search for those concepts in the data (Elo & Kyngäs, 2008; Hsieh & Shannon, 2005). For the purposes of this research, literature from the areas on novice – expert differences in ISAD and on the ISAD process was sufficiently rich enough to determine broad categories which provided the appropriate search space for potential gaps in knowledge or understanding. In conventional or inductive qualitative content analysis the researcher analyses the text to create abstractions which eventually become the concepts of interest. Concepts are drawn entirely from the text without the researcher imposing some preconceived concepts onto the data (Elo & Kyngäs, 2008; Hsieh & Shannon, 2005). This is most useful in areas where the knowledge about the phenomenon under study is sparse. Within each predetermined area of interest, open-ended questions were asked and the subsequent data was analysed using an inductive approach to determine and summarize the various concepts that emerged.

## 4.5 Educational Environment

### 4.5.1 Introduction

This section describes the educational environment in which the research study took place. It provides understanding about the students and their supervisors, the types of projects they undertook, how teams were created and allocated and the overall educational environment with regard to learning materials and assessment. This section addresses the trustworthiness guidelines of *transferability* and *dependability*. With regard to transferability, by describing the educational environment the reader will understand the context of the study and should be able to judge the extent to which the results of the research might be transferable to existing or new contexts. It is relatively common for courses to have Capstone projects which involve real world clients with real problems in some form students and typically don’t have much, if any, professional experience. The students in this study appear to be fairly typical in this respect. With regard to dependability, the experience of the participating supervisors of working with students was over several semesters and not just a single semester, so the supervisors' observations go beyond a single cohort of students.

### 4.5.2 Background to the capstone project experience

Team projects are used to prepare students for the IS/IT industry. These projects are offered to students from a wide variety of undergraduate and postgraduate courses but in every case it will be taken in the last year of their course. The project runs for one semester (12 weeks typically) only and counts as one subject in their course of study. As an example, a student enrolled in the undergraduate program Bachelor of Business Information Systems is required to complete 24 subjects in total in order to qualify for the degree. For a post-graduate student it will be one subject of a 12 or 16 subject course. Depending on the student's course and particular circumstances, a student could be doing up to four other subjects concurrently with the project.

Students are provided with an analysis-based project provided by a client in a real organisation with a genuine problem or opportunity that can be addressed through the effective use of IT. The projects are initially screened and chosen by the subject convener to ensure that they are appropriate for the subject in terms of type of project, scope and time frame for completion; that the clients' expectations are reasonable and that they are committed to seeing the project through to completion. Problems are selected that require analysis, investigation and recommendations but do not require implementation since teams take on the role of analysts and not technical developers. At the completion of projects, the client organisation may themselves implement the recommendations or they may take the students report as the basis for their own further investigation or sometimes the work is passed on to a new team of students in a different project subject and that new team develops and implements the recommendations.

Students normally work in teams of three or four. There is a common lecture time of up to two hours per week and a tutorial as needed which students are expected attend. Lectures are conducted most weeks and targeted toward providing information to students that is expected to be relevant at that time within the projects (e.g. interviewing clients, project management, presentation skills etc.) or supplementary information (e.g. teamwork, personality types, leadership etc.).

Teams are expected to apply knowledge and skills that they have learned over the previous parts of their course in order to solve a real problem presented by a client from industry. In the past students will have worked in teams to work on assignments which were typically well thought out and clearly defined. In contrast, in these projects the problem and its scope is almost certain to need a great deal of clarification and may well change, the expected outcome will need to be negotiated between the client and the team and teams need to determine and execute an appropriate process to achieve the expected outcome. Although students are used to working in teams on assignments, the scale of the project tests and extends their management and teamwork skills. Teams are overseen by an appointed supervisor who they meet with each week for around 30 to 60 minutes. The supervisor works in the background as a mentor, coach and guide to ensure the project stays on track to the benefit of the students and client as well as meeting the subject requirements.

### 4.5.3 Student backgrounds

Courses in which the participating students are enrolled varied. Some courses are Information Systems based (e.g. Bachelor of Business Information Systems and various double degrees with Bachelor of Business), while most others typically have significant proportion of Information Systems type subjects together with more technologically based subjects.

The postgraduate students were enrolled in Master's courses with a significant proportion of Information Systems subjects together some technology based subjects. Most post graduate students are international in origin with a prior degree which is often technical in nature (e.g. programming, networking). All international students have been studying for at least a year at Swinburne but that does mean that they will necessarily be totally familiar with Australian culture and norms particularly when it concerns working within an Australian business context.

Some undergraduate students had some industry based learning experience (up to 10 months) as part of their studies, while some had no such experience. A few Master's students had some industry experience as well. There were male and female students across the undergraduate and postgraduate students.

The wide range of student backgrounds is seen as a positive feature because it expands the applicability of findings as is suggested in phenomenographic studies (Green, 2005). Some research approaches rely on large numbers of participants (as in a medical trial) to justify their validity and usefulness in a practical sense because they are concerned with statistical probabilities. The wide ranging set of student backgrounds in this study suggests a correspondingly wide range set of different types of responses which, in turn, suggests that results will be more generalizable i.e. that a subsequent student with a background similar to the study group is likely to respond in manner which is within the determined range of responses.

### 4.5.4 Supervisor backgrounds

The supervisors in this study have significant practical understanding and skill in solving real world problems with real world clients. A supervisor who has only academic qualifications and experience (however extensive) would not have qualified as a truly suitable “master” or mentor in this application Cognitive Apprenticeship Model (described below) because of the lack of professional experience.
The original term “master” did not seem particularly appropriate in a modern context so the supervisors interviewed in this research have been described as “experts”. The definition of an expert used here involves fulfilling a combination of the following:

- A relevant academic qualification in information systems or relevant area. Typically a Bachelor’s degree by accrediting bodies such as the Australian Computer Society (or equivalent international body) would be the expectation although there are many experienced and successful IS practitioners whose original degrees were from other areas.
- Practical experience in information systems analysis and design in a wide variety of situations and sufficient skill developed to be able to work in a relatively intuitive way. Five years of equivalent full time experience is suggested as a minimum.
- Recognition within the practitioner community for their knowledge and experience. Examples of recognition might include working successfully as an analyst for well-known organisations, promotions to a senior analyst role in a well-known consulting firm, industry awards or requests to speak to appropriate audiences in the ISAD area made by bodies or organisations that have significant recognition within the practitioner community.

The supervisors who participated in this research met or exceeded the three requirements above particularly with regard to the number of years of experience. The following provides a brief overview of the background of each supervisor who is identified throughout this thesis as expert D, expert G, expert J or expert P:

- **Expert D**: 22 years' experience in roles as analyst, senior business analyst, project manager, team leader, consultant and development manager across private, public and government organisations and different industry sectors. Three Masters Degrees spanning across the areas of Information Technology, Information Systems Management and Business Administration.
- **Expert G**: 30+ years' experience. APMG Registered Consultant working with global organisations to assess maturity and build capability. Broad experience as a senior consultant and project manager across industries including Banking, Telecoms, Government, Infrastructure and Utilities. Worked in Europe, US and Australia. Principal Consultant with a medium sized independent project management service provider. Serves on a number of industry committees. Master of Business Administration.
- **Expert J**: 30+ years' experience including 20 years' experience with several global and national organisations which provide IT/IS services. Worked with private, public and government organisations in a variety of consultant/analyst roles. Skills in requirements analysis, data analysis, software development, business process analysis, project delivery. Bachelor of Arts.
- **Expert P**: 15 years' experience in roles as systems analyst, IT manager, IT consultant, small business owner developing and selling software to the welfare area. 30 years' experience in higher education as lecturer in IS, program manager and IBL coordinator and supervisor. Over many years managed capstone projects units and supervised hundreds of capstone projects with real world clients. Degrees in Accounting and Information Technology

### 4.5.5 Allocation of teams, projects and supervisors

Students are allocated to teams by the subject convener at the start of semester, although there is always some last minute manoeuvring as students drop in or out of the subject or describe some special circumstance that might require a change of project or team. Supervisors are also allocated to project teams by the convener. When there are multiple different projects and supervisors, attempts are made to match the supervisor's knowledge and skill set to the projects.

The team selection process is mediated by the various different projects that are available. The knowledge and skills sets needed for projects are determined by the subject convener (in consultation with colleagues as needed) and teams are formed which have complementary knowledge and skill sets which meet the project's needs. This process typically requires reviewing each student's academic background together with other students and trying to put together a team that has the knowledge and skills required for their project. This is a time consuming process, however, based on the experience of this researcher the time spent appears to be worthwhile because it reduces the potential for problems later and increases the likelihood of a satisfactory outcome for the client. Projects for which no reasonably competent team can be assembled are not accepted.

Within this particular iteration of the capstone projects all except for one team were assigned to the one project and set of clients. These clients generously provided their time to conduct both group interviews with all teams and one-on-one interviews with each team. In other semesters, there were multiple projects and clients and the expert supervisors who were interviewed as part of this research were also involved with these other projects.

### 4.5.6 Assessment

The supervisor assesses both the team as a whole and each student individually. There are team deliverables as well as individual deliverables. Team deliverables include a project problem and scope description, a background briefing document, mid-semester progress review, final presentation and final report. Individual components are the students' journals and an individual mark for the final presentation. The final presentation is assessed by three academic staff (one of whom is the supervisor) while the final report is marked by the supervisor and moderated by another staff member for consistency. There is also provision for adjustment of the group marks based on contribution to the project. This mechanism for this process was developed by this researcher and is described in some detail in a paper by Farrell et al (Farrell, Ravalli, Farrell, Kindler, & Hall, 2012) for which this researcher was a co-contributor.

#### 4.5.6.1 Background briefing on the organisation and knowledge area of the project

The background briefing is a team based report of up to several thousand words providing a background to the client's organization and the specialized area of knowledge relating to the problem domain. Making an effort to gain an understanding of the client's organization helps students to develop the problem context. With regard to the knowledge area, this relates to trying to determine and develop an understanding of the problem space and potential solution space. For example, a client describes that they have difficulty with specialist knowledge not being shared effectively among staff and then being lost when staff leave. This might suggest a problem with knowledge management and so the team would do a review of knowledge management from a business and IT application perspective. The intention here is that students very quickly develop a broad understanding of the concepts, issues and possibilities within the problem domain.

#### 4.5.6.2 Mid semester progress review

The mid semester progress review is a formal presentation describing the problem, project scope and progress so far. Attendees are the client(s), student team and team supervisor. Its purpose is to force each team to write down, clarify and formally express what they know. It is also something of a "wake up call' for teams slow in getting started. Also, given that the supervisor normally does not attend the client and team face-to-face meetings it gives the supervisor an opportunity to meet the client and discover first-hand how the project is progressing from the client's perspective.

#### 4.5.6.3 Final presentation

Team presentations are conducted with attendance of the client and other interested parties from the client's organization. It is jointly assessed by three academic staff including the team supervisor who may be able to offer insights into the project which may not be apparent to the other assessors or even the team (e.g. regarding project's difficulty or issues regarding the client).

The team presents the problem as determined by the team, a description of the process they used to come to their recommendation and the recommendation(s). Clients are usually quite supportive of the team and, if so, this forms a satisfying ending for each team especially if they have worked hard to obtain a satisfactory result.

#### 4.5.6.4 Final Report

The final report is a document presented to the client and supervisor and is a more detailed description of the project than was possible to provide in the final presentation. The client is typically most interested in the practical worth of the team's work in terms of how well have they understood and described the problem and how well the recommendations appear to solve the business problem. The supervisor assesses the academic worth of the report in terms of appropriate and effective application of knowledge and skills previously covered in the course, investigative skills shown, critical thinking and creativity. There is a rubric to follow, exemplars are available if needed and when external supervisors are involved the team reports will be reviewed by an internal academic familiar with capstone project reports.

### 4.5.7 Cognitive apprenticeship environment

This researcher established the capstone project learning environment as well as managing and administering the capstone project subject. The subject implements many aspects of the Cognitive Apprenticeship (CA) model of learning (J. S. Brown, Collins, & Duguid, 1989; Collins, Brown, & Holum, 1991) because many aspects appeared to be supportive to students working on a capstone project. This model is also a “natural fit” in that at its core is the idea of experienced professionals providing guidance and support to their relatively inexperienced students. Dennen and Burner (2008) provide a general overview of the model and numerous examples in which it has been applied. A few illustrative examples of application of the model which are in the higher education area include avionics and medicine (Lajoie, 2009), clinical practice in the health sciences (Stalmeijer, Dolmans, Wolfhagen, & Scherpbier, 2009), performance systems analysis (Darabi, 2005), computer engineering (Murray, Ryan, & Pahl, 2003) and doctoral education (Austin, 2009).

Although students were asked about and able to comment on those features of the CA model that were implemented, this thesis is not focused on evaluating the CA model implemented.

#### 4.5.7.1 Cognitive Apprenticeship overview

The term “cognitive apprenticeship” was used by Collins et al. (1991) to describe the idea of synthesizing the more traditional apprenticeship model of instruction with the teaching of more conceptual subjects in the educational environment; hence the descriptor “cognitive”. The Cognitive Apprenticeship model is a set of guidelines and suggestions on how teaching can be approached. As Collins et al. originally suggested it is more appropriate in areas of complexity and judgment and not in areas where what is to be learned is relatively straightforward.

Collins et al. identify three important differences between the cognitive apprenticeship and a traditional craft apprenticeship. First, in a craft based apprenticeship the student can see the task that is being performed. In a cognitive apprenticeship one must identify the tasks and make the thought processes of the instructor visible. Similarly, the student must also make their thought processes visible. Second, in a craft based apprenticeship the value of the final product and skill being developed is tangible. In a cognitive apprenticeship, the tasks need to be placed in an authentic context and its relevance made clear. Third, in a craft based apprenticeship skills are not expected to be transferable. In a cognitive apprenticeship, however, teachers must diversify the situations in which students apply their skills so they learn to generalise them and be able to apply them in novel situations.

The framework provided by Collins et al addresses four areas: content, methods, sequencing and sociology. The area of content is broken down to domain knowledge, heuristic strategies, control strategies (also called metacognitive strategies) and learning strategies. Methods relate the possible teaching strategies which can be employed for example modelling, coaching, scaffolding, articulation, reflection and explanation. Sequencing is vital to effective ordering of learning activities e.g. teaching global before local skills, increasing complexity and increasing diversity. Sociology relates to the social characteristics of the learning environments such as students learning in the context of realistic tasks, a community of practice in which people share their knowledge of how to accomplish meaningful tasks, developing motivation by allowing students to set personal goals to seek skills and solutions and encouraging cooperation between students to accomplish goals.

## 4.6 Collection of research data

### 4.6.1 Introduction

This section addresses the research quality guideline of *credibility*. It describes the data that was gathered and the manner in which it was gathered. Ethical issues regarding gaining consent, privacy of participants, removing the potential for coercion (perceived or real) or introducing bias in participants' responses are discussed.

The empirical data for this research was obtained from students and expert team supervisors. Students provided their responses through written journals which they submitted at regular intervals. Journals asking for student's perceptions of the project and team work have been a long standing mandatory item of assessment for all project students in the past. Writing journals for this study presented no extra burden on students and students only needed to provide their consent for their journal responses to be used for research purposes.

Supervisors gave their consent to be interviewed over two or three sessions over and above their commitment to supervising student teams. In these interviews the supervisors provided their own interpretation and understanding about the projects and students' understanding of and how they coped with various aspects of the projects. Supervisors were encouraged to be honest and appeared to be very forthcoming during the interviews.

The following sections elaborate on the student journals and supervisor interviews.

### 4.6.2 Interviews with expert supervisors

The four experienced analysts who participated as project team supervisors had been supervising teams across several semesters including the one in which students provided their journals for analysis. Their broader experience adds to the depth of the understanding of students they had regarding capstone project students beyond a single semester. The importance of these supervisors to the research lies in the professional expertise which each provided about ISAD and their particular interpretation and perspective on the behaviour or thinking that students displayed. This was consistent with the context of the "master-apprentice" model and considered more intrinsically valuable to this research than interviewing, say for example, other supervisors who did not have such professional expertise. Each of the interviews with supervisors was based on a set of predetermined questions covering similar topic areas as was covered in the student journals.

Two of the expert supervisors were interviewed twice and two were interviewed three times. The difference in the number of interviews was based simply on their availability but the same topics were covered overall. These interviews ranged in duration from nearly one hour through to one and half hours. The original interview questions are provided in Appendix B.

Typically, the interviews did not follow the original sequence of questions very closely but eventually responses were obtained for all the questions at some point within the interviews. Allowing the interviews to meander somewhat was intended to support and encourage each supervisor to speak freely, to help the interviewee develop their own ideas and sometimes to probe a topic further if an interesting idea emerged that seemed relevant. This is consistent with this type of inquiry (Green, 2005; Sandbergh, 1997;

Trigwell, 2000). At times, this free ranging and exploratory approach was an opportunity to challenge the supervisors to reflect more deeply about their initial thoughts.

Each interview was subsequently transcribed verbatim by this researcher.

### 4.6.3 Students' structured journals

All students (35 in total) were required to submit journals providing their reflections regarding project work. In total, there were three submissions from each student which form part of this research. Journals were required to be submitted every four to five weeks with the first journal due around week 5, the second in week 9 and the last journal in week 14. There was also an initial student journal submission prior to the start of the project to which students responded which asked students about their perceptions of capstone projects prior to beginning their projects but this is not included as part of this thesis. The analysis and results of this journal submission, however, were reported in Ravalli and Stojcevski (2011).

The journals were structured as sets of open ended questions which asked students to discuss their understanding and perception of the project at that particular time across a variety of topics. The questions were also focused on events that ought to be occurring around that time. For example, in the first journal some questions related to problem understanding and perceptions about the client, in the second journal questions were asked about researching solutions and team work while in the last journal questions were about preparing for presentations and reflections on the project as a whole.

The journal questions that students answered were intended to help students reflect about what they are doing and learning as they work on their project. Unstructured journals (or more recently blogs) where students write about what is of interest to them are limited in their usefulness because they tend to display and, perhaps to a degree extend, what students already know or ways they view the world. To develop professional judgment one needs to be challenged to think beyond one's existing ideas and ways of thinking. The structured questions in these journals were intended not only to display or extend students existing ideas but, by addressing a wide variety of ideas and different levels of abstraction, take them into areas that students may not have considered before or considered in depth. For students, the journals' aims were to:

- help them become aware of what they did and did not know.
- connect prior knowledge and skills with the project that they are working on.

- summarize their knowledge and encourage insight into understanding.
- develop their critical thinking skills

Journals were individual and not disclosed to other students. Each team's supervisor was expected to read the journals of their students as they were submitted. This enabled the supervisor to determine students' understanding of the project and how they were faring so as to be able to provide appropriate feedback and guidance. Journals were graded but it was made clear to students (and supervisors) that this grading was purely on the basis of the effort put into answering questions and depth of thought shown and not on the basis of "correctness". Honesty and criticism were encouraged. The emphasis was on trying to obtain authentic expressions of students' understandings and perceptions of their project experience.

Consent was obtained from students to use their journals for research purposes. Ethics application and approval and the consent forms that students were asked to complete are provided in Appendix D. The student journals that students completed were analysed well after completion of the project and students' academic results had been published so as to avoid any ethical problems.

### 4.6.4 Development and trial of student journals

A pilot study was conducted in the semester prior to the journals used in this research. This was worthwhile because it became clear from the pilot study that the intention of several of the original questions were clearly not well understood by some students or were not well framed from a research perspective. Subsequently, questions were modified so that they were clearer, some questions dropped or new ones added. The result was that questions were more clearly focused on issues of judgment (related to ISAD) or cognitive apprenticeship (CA) or both without compromising the intent or value from the students' perspective. The student journal questions can be found in Appendix 1. Each question is accompanied by an explanation of its intended purpose. Anecdotally, students suggested that they found the questions understandable and that they were sometimes challenged to think about aspects of their work that they would otherwise not have considered. The range of effort put in by students was quite variable with some responses being long and thoughtful and others very brief and superficial.

# 4.7 The analysis process

## 4.7.1 Introduction

This section addresses the research quality guidelines of *credibility* and *authenticity*. It begins by describing the qualitative content analysis method used to analyse data. In terms of *credibility* it describes in some detail the analysis process and the iterative manner in which the data was reviewed and compared and reviewed again several times so that it was faithful to the idea of capturing the ideas accurately and in a rigorous manner. A high level summary appears within the main body of the thesis and a more detailed description is provided Appendix C. Extensive use of quotations is provided in Appendix C to demonstrate the *authenticity* of the concepts to demonstrate that they captured the intentions of the participants as well as adding to its *credibility*.

The ideas put forth by the expert supervisors was felt to be of particular interest and these were reported in significant detail because they represented the thoughts of well qualified and thoughtful individuals with obviously a great deal of experience as professional analysts. They also had experience in supervising several teams across several semesters so their perceptions about students is the knowledge gained through working with several cohorts of students and not just the one cohort in this study. It is believed that this adds to the *dependability* of the findings.

## 4.7.2 Analysis process for supervisor interviews

The approach taken to analyse the supervisor interviews was to go through each interview draft looking for the different ideas that emerged. One tries to determine underlying abstract concepts that the interviewee appeared to be making based entirely on the data. One pass through an interview transcript was never enough to really understand the data and capture its meaning. Several passes were always required during which time this researcher’s understanding of concepts changed or were refined until they finally stabilized. Throughout this process each concept was linked back to the particular comment(s) made by the interviewee by reference to the particular interview transcript (each interview transcript was coded) and to the particular response within the interview (each response was also coded to identify them). This reference of a concept back to a statement from the interview transcript enhanced *credibility* and *authenticity*. This linking is meaningless to the reader without the original transcripts and is not shown in this thesis however the reader will note that quotations are used liberally in the following chapter discussing the expert analysts' perceptions.

After analysing of all interview transcripts separately the concepts that emerged were brought together and then reviewed as a whole again. This review process also required several iterations to develop an overall summary that captured the underlying concepts authentically. Eventually, after several iterations a stable description emerged. This final stable set of concepts was reported and discussed in Chapter 5.

### 4.7.3 Analysis process for student journals

Students' journals were initially analysed one question at a time. With each question several iterations through all the data were required to determine the different concepts. Each concept determined was linked to the corresponding students' statements to ensure the authenticity of the concepts proposed. Although this was not precisely a thematic analysis the number of times a particular concept was mentioned was counted as was the number of times concepts appeared together so as to get an idea of how prevalent ideas were among students. Given this, the results could also be used on the same basis as a thematic analysis. The detailed results of the journal analysis were provided in Appendix C. These detailed results present the concepts determined and their frequency of occurrence and are supported and illustrated with student comments.

Chapter 6 provides a summary of the detailed results. Making use of the frequencies helped to focus the summary on the more prevalent results but there is also discussion of some of the less prevalent ones that were particularly interesting. Even in a thematic analysis the researcher might judge a potential theme to be of such importance or interest that even if the frequency is low it might be an included in the final description (Braun & Clark, 2006; Buetow, 2010).

## 4.8 Chapter Summary

A Constructivist epistemological position was taken which is commonly assumed within educational research. The research question related to finding the gaps in professional judgment of final year students compared to expert analysts and determining how those gaps could be reduced or eliminated. The existing literature on this matter is not extensive and it was not clear in which areas those gaps in judgment might occur. A qualitative and holistic approach was deemed to be the most appropriate way to develop a deep understanding and insight of those gaps in professional judgment and hence to develop appropriate recommendations.

A pilot study was conducted to test the materials developed and the research process. This led to a refinement of the materials and process. The results of this pilot study were not included in this study.

Many features of the Cognitive Apprentice model were adopted as part of the educational environment however this model was not the direct focus of this research. Consistent with the Cognitive Apprenticeship approach, supervisors met with their assigned teams on a weekly basis to discuss their progress and share their understanding of the project and through this regular activity supervisors developed a deep understanding of students' professional judgment as they conducted their projects.

Data was gathered from supervisors through several interviews and students responded in three semi-structured journals on three predetermined occasions during the conduct of projects. Qualitative content analysis was adopted as the best tool for analysing data due to its flexibility. Supervisor interviews were transcribed and the data was analysed using an inductive approach. To understand and to adequately represent students' and supervisors' concepts many iterations through the data were required to refine the results to a satisfactory point.

Guidelines for judging the trustworthiness of qualitative research were suggested: credibility, confirmability, dependability, translatability, and authenticity. To demonstrate that the research was conducted at an appropriate standard the manner in which the guidelines were adhered to was discussed as the research approach and process was described throughout the chapter.

The next chapter deals with the expert analysts' perspectives regarding how students coped with their projects and how the supervisors themselves dealt with the supervision process. It provides an analysis and summary of the interviews that were conducted with the supervisors. Many quotations from the supervisors are provided to support the authenticity of the findings.

# 5 ANALYSIS AND SUMMARY OF ANALYST INTERVIEWS

## 5.1 Introduction

The methodology for developing interview questions and the qualitative content analysis method for analysing was described in Chapter 4. A framework of questions had been established from the beginning so this was a partly deductive approach. However, the supervisors were then free to answer them as they wished which they often did in some detail and with the discussion becoming quite free ranging at times. Supervisor responses were analysed with as much objectivity as possible and each concept relating to differences between students and the experts which emerged was supported by its supporting quotations. Finding these concepts was then a hybrid approach incorporating initial ideas of the possible concepts that might be of interest together with concepts developed from an inductive analysis.

The initial part of this chapter is a discussion and presentation of findings from the expert analysts interviews placed within the context the typical flow of project events starting from examining the project description, first interviews with the client, problem definition and scoping, researching solutions and finally presenting solutions. This is followed by findings relating to project management which span across the project.

These are subdivided into team dynamics and client management. The chapter concludes with findings relating to the supervision process.
In the following discussion the four experts are identified as expert G, expert J, expert D or expert P. Their backgrounds were described in Chapter 4.

## 5.2 Problem understanding and determination of project scope and goals

### 5.2.1 The project brief

The project brief is written by the client and describes the client's perspective on what the project is about. They will describe the problem and project goals. Prior to allocating them to students project briefs are vetted by academic staff for their general suitability but they are not modified. From the beginning, we see differences between expert supervisors and students in their approach to these project briefs.
**A1 Students tend to believe that the original project brief will be an accurate description of the project.** Based on their greater experience the experts were aware that the clients who produce the project briefs are probably not skilled in this in this task or may not, for whatever reason, have put a great deal of thought into it. Expert G cautions, "*the brief is often not well articulated*" and suggests that the client may "*sometimes have a very clear understanding of what they want because the whole business is in their head ... but not how to get there*". Expert P is blunter, "*sometimes the client doesn't know what the problem is*" and at another point states "*the problem statement given to them by the client is from the client's perspective but often … the problem statement given by the client is superficial*". The experts' perspective of the client's original project description is therefore that it is the starting point for further discussion, clarification and negotiation.
**A2 Students tend to believe that the project brief is not negotiable.** When students approach the project brief, Expert G's view was that students who have little or no experience will extend their past experience in academia with assessable items of work like assignments, "*I think it's part of moving through academia. You're at school and you're told what to do. You're told that you have to get your home work in on Wednesday – there's no negotiating there. Whereas in reality there is…*" Academic assignments are for the most part definitive and non-negotiable and they tend to regard

the project brief in a similar light. Extensions of this line of thought are that if they don't understand the project brief they may be inclined to see the problem as lying within themselves or hesitant to question the project scope and goals.

In spite of the wariness that the expert has for the quality and correctness of project brief, Expert D, for example, certainly did not dismiss the project brief but described the care with which he read it so as to understand the client's current perspective of the problem to be solved, project scope and goals. He would then do background research as required to gain some familiarity with the problem domain.

## 5.2.2 From project brief to first interviews

In preparing for and in conducting their first interviews with the client, students are often unsure or possibly misguided about the questions they should be asking. In this section, the experts gave several explanations for the strategies that students demonstrated when preparing questions for their client interview.

### 5.2.2.1 Understanding the problem in its context

It would appear fairly self-evident that with their projects students must first understand the client's problem and client's needs, expert D,*"… start talking about what is that you want? What is the problem that you need to solve? … get a better understanding of their overall business problem*". However the strategy for how to go about this and the amount of effort that needs to put it into the various aspects involved is not so self-evident and requires knowledge, experience, and judgment.

**A3 Students often do not appreciate the importance of doing background research and becoming familiar with the problem domain.** Expert P expected students to have done some homework based around the project brief. "*You have to ask the right questions. You have to show an element of understanding of the industry. I always tell the students before you go to see the client look at the website. See if they've got a website. Get an understanding of what the business is all about. If there's no website find similar organizations just to get an overview of what they're trying to do.*" If students suggest that they intend to ask the client, "What does your business do?", then, "*if you don't know what the business does before you go out there then you haven't done your homework. Students should at least have some context in terms of what the business does.*" For the question "*What do you see is the problem"* he suggests that this *"question is okay but in a context. But to walk in there and say what do you see as the* *problem with no context doesn't make sense.*" For expert P this background research is particularly important because "*there is an element of trust that has to be built up between the client and the group and that sometimes the client won't just open up and do a complete dump of everything. They will hold back until that element of trust has been developed which happens in real life. A lot of my work is done in that sort of area.*"

**A4 The lack of awareness or appreciation of the need to truly understand the problem within its context can lead to students prematurely deciding on a solution and thereafter being "solution focused".** This is something that all the experts noted among their students. Being "solution focused" is a term used here in a pejorative sense to suggest that a decision has been made prematurely about the nature of a solution or recommendation with insufficient research in understanding the problem and its context. Expert G stated, "*My experience of the groups that I've supervised so far is that there is a lot of initial enthusiasm and they read the project brief given and they go straight into solution mode and base the questions they're going to ask the client on what they see as a … solution.*" With one team, Expert D described that, "*They were thinking solution mode. They were thinking solution as opposed to trying to understand the client's needs.*" Expert J simply said, "*They were completely solution focused as far as I was concerned.*" An extreme example of being solution focused was described by Expert P regarding his first meeting with one of his teams and prior to the team even meeting the clients, "… *when I first met them, from their perspective they had already solved the problem. They were solution bound which means that they hadn't thought very deeply about the problem. They had come up with a solution and they were trying to make the problem fit into the solution.*" In this case, one of the team members had worked in an organisation which had a similar problem and he was convinced that exactly the same solution could be applied in this case without due consideration of the different circumstances which applied. Expert P, "*They broke all the rules in terms of good analysis and, okay, we're all guilty of that to some extent that we are pre-empting possible solutions because that's the way we operate but a good analyst will have an open mind until they understand the problem and have fully understood the requirements of the user and the client and then start formulating possible solutions. They were looking for requirements to fit their solution all the way through the project.*" With this particular team he was particularly blunt, telling them, "*You have come up* *with a solution and you haven't opened your eyes to absorb some of the other things related to the problem*".

**A5 The strategy sometimes adopted by students of working backwards from the deliverables or objectives stated by the client in the project brief can lead to being "solution focused".** Expert G suggested that students assume that the project brief as described by the client is correct and they work backwards from the deliverables stated by the client. This can also be construed as being solution focused but in this case it is the client's perception of the solution, expert G, "*They often don't know what questions to ask and because they're getting it into their mind what they've got to deliver they'll base their questions on that.*" This assumes that the client has satisfactorily defined the underlying business problem, understands all the requirements and has been able to identify what needs to be delivered. While this might be true in a few projects, this is not typical of the majority. Adopting this strategy may deliver to the client what was asked for but it may not deliver significant benefits. It is the easy option because it allows students to avoid having to question the client's statement of the problem or to investigate the requirements thoroughly or to question whether requested deliverables are appropriate. Expert D for example describes a situation where a client requests an email facility in order to contact other staff members. Such a facility could be provided but would be ineffective if the other staff don't have access to email or choose to ignore it. As Expert D describes, "*Often people will give you a requirement which is cleverly disguised as a solution. So they will tell you about the email but what their real problem is something else. It's in their mind so what they're telling you is what they think the answer is. It is difficult for you sometimes to add value when they do that.*"

5.2.2.2 Assumptions

**A6 Students will tend to make assumptions about various aspects of the project and then overcommit themselves down a particular path**. The issue with which experts are very aware is best captured by Expert G who suggests that both clients and analysts will have made assumptions based around the project brief, "*The whole point of having that meeting [with the client] as soon as you can is [that] … you're making assumptions, they've made assumptions.*" Expert G suggests that students read the project brief and then can overcommit themselves down a particular path, *"… they get a brief, they make their assumptions and they sort of almost create a model around it about … what they have to do and then that gives them some certainty.*" The effect of this, however, is that they can walk into the interview prepared with a list of questions for the client based on false assumptions and then as Expert G describes, "*They have the meeting, they come out and they say, "It wasn't that at all. What do we do now?"*". These assumptions include the understanding and the nature of the problem by both the client and the team of students, the capabilities of the client and other potential stakeholders and the team of students assigned to the project; it includes the client organisation and the industry it is in, the capabilities and resources of the organisation; it can include assumptions about potential solutions and so on. The earlier they can uncover any false assumptions the better.

**A7 Students do not appreciate the need to test their assumptions nor are they necessarily aware that they have made them.** The experts are more aware of the risks of making assumptions and also keenly aware that they need to test their assumptions. Expert D, for example, describes several occasions stressing to students about the importance of validation of their assumptions including assumptions about deliverables, about timelines and assumptions about the client's budget. For example, expert D: "*Well, I hope [the team leader of team J] got that. … He appeared to understand it so I'll have a look at his assumptions at the end to see whether it really clicked. I explained why and he seemed to take that on board and he seemed to understand it.*" At another point Expert D describes how he questioned an assumption that a student had made, "*So I asked him why you're thinking that's an important assumption? What is it that you are really trying to say here? So we dug a bit deeper.*"

Students are much more likely than the experts to make assumptions either through lack of appreciation of their impact or through ignorance. This occurs largely through their lack of experience dealing on a more professional level with people in business, organisations and conducting projects. Even though they are now in their last year of their course expert G noted that, "*their knowledge is quite broad but fragmented.*" At another point, expert G suggests of the students that*, "They've just spent three or four years studying a fairly narrow stream of work. Having been through school and having done their VCE equivalent which is going to be fairly narrow too, their ability to see a problem wider is more difficult*". One common issue that all the experts were cognizant of and discussed with their teams at various times was the extent to which the client and their organisation have the capabilities to make effective use of whatever might be recommended or delivered by a project. Expert G, "*Now, you can deliver that capability but if the organisation isn't geared up to use it it's not going to deliver any benefits so a* *lot of what I'm looking at is a broader business picture and the environment the organisation works in*". The example given by Expert P of the student team which had "solved the problem" before the first client interview provides a good demonstration of ignoring the problem context and assuming the appropriateness of recommended the solution to the client and organisation.

5.2.2.3 Developing questions using a "first things first" or "top down" approach

**A8 Many students have a relatively poor strategy in terms of asking questions**. Expert P observed this was the case with a significant proportion of students, "… *they don't know how to get the information out of the client*". Here he provides his observations, "*Yes, so all of a sudden they are thrust into that sort of situation in dealing with the outside world. Now some of them do well. Some of them have no idea and that's why they don't get a firm grasp of what the problem is until they have had at least three meetings. I had one group, I think the client just shutdown. They kept ringing him up [indicates exasperation] I think I got a statement, an email from the client saying, '[Student name] is really enthusiastic but can you calm him down a bit?'*". Expert P provides his explanation why some students don't do well in interviewing, "*They don't understand about the top down approach where they're right into the bowels or the detail, minute detail. Can you tell me what happens when a client does this or that, or rings up, what you do in that situation?*" A top down approach is one which begins at the highest conceptual level and works down its way to the details. Questions involving low-level details, such as for example what happens at some point in a current business process, are both distracting and may later prove to be irrelevant. As expert P finds, "*It is quite difficult and I don't think it's something that you can easily teach but then in some respects most people probably get more out of that project than the one where the project is clearly defined.*"

**A9 Students typically don't have a holistic view of a project and don't necessarily foresee the consequences of information obtained or decisions made on other aspects of a project.** The experts, with their experience of many projects, see problem definition, scope determination, requirements gathering, research into solutions and delivery of the end product as an interconnected whole. As suggested in Chapter 3 however, it may be relatively chaotic process in which events such as knowledge obtained or decisions made at any point of the process may have consequences necessitating changes up or down the line. For example, discussions about scope may well necessitate changes in problem definition (up the line) and deliverables (down the line). The experts have developed mental models of project work which gives them a better insight into their working which then guides them when events occur as to their possible consequences and their relative importance. Without the same type of sophisticated mental model to guide them, students can easily be overwhelmed by events or assign too little or too much importance to events that occur. This is where supervisors can advise students.

In developing an appropriate set of questions for the clients, supervisors can provide some guidance. Expert P, *"… I tell them I'm happy to vet the questions and go through them and probably 70% of groups send their questions first. I go through them and I tell them I can't see the relevance of that question and why aren't you asking a question related to this and so on. So I actually provide some guidance*".

## 5.2.3 First interviews

### 5.2.3.1 Managing and dealing with the client meetings

All the experts discussed and emphasized the idea of "managing the client" which will be discussed in more detail later. The relevant aspect of managing the client at this point involves working with the client to understand and define the business problem and developing an appropriate scope and goals for the project.

Interviewing the client is not an easy situation for students because they are not sure what questions to ask. Expert G comments about clients that, "*they sometimes have a very clear understanding of what they want because the whole business is in their head*" but "*what they don't know is how technically they can achieve what they want*". On the other hand, students begin knowing very little about the business and need to get the information out of the "client's head" by asking the right questions.

**A10 Students may not clearly understand the analyst role they are playing within the projects.** Experience suggests that some students do not understand their role. For example, after an interview with their client, a team of students came to expert P with the comment, *"they need a database so we thought we could set up something in Access [a database software package]*", so clearly they believed, incorrectly, that they were to build a solution for the client when, in fact, their role was limited to analysis and making recommendations. Expert J had a similar experience with one of his teams, "*They certainly had the issue with it being requirements type analysis unit and not a build … no matter how many times I told them.*" At another time Expert J commented, "*you had to give them a bit of a wack every now and then and say, "Remember, this is requirements analysis.*""

**A11 Students can have difficulty managing the client interview so that they can satisfactorily achieve their goals.** The great majority of clients who volunteer to provide Capstone project are very supportive of the students. However, these clients don't necessarily know the information the students need. One assumes that the clients are intelligent but essentially amateurs (meant in a non-pejorative sense) in terms of IS development processes. This is why it is the students' responsibility, as best they can, to manage the interview rather than to let the client take charge. Expert P was particularly aware of the difficulty that students faced,

> *"… what we don't teach them is how to control that sort of situation, how to manage the interview situation. I did try and maybe I don't do a very good job of it but I always suggest to send the questions to the client first so the client knows and is prepared for what you're trying to achieve out of the interview. I tell them that you should have an objective in terms of what you're trying to achieve out of it. You should have a plan. The interview process diverts from the plan then you need to work out ways how to get back on track. [For example] 'All of that is really interesting. Can I follow that up in a subsequent meeting?' [or] 'It's really good. It's really good information but would you mind if we came back and followed that up?' They don't know how to do that.*"

So that students did not go off track, one of the important duties of the expert supervisor was to ensure that the students operated within their roles as analysts and within the scope of aims and restrictions of the capstone project unit. As Expert G found, "*I think that first supervision session after the first meeting is always quite interesting. They come back and you find out how they're feeling about it and then, getting information off them, trying to give them some guidance on how to handle that.*"

5.2.3.2 Superficial or incomplete understanding of the problem or requirements

**A12 Students often struggled to determine the underlying business problem that needed to be solved.** All the experts suggested that the problem originally posed by the client needed to be critically examined and often needed to be modified. Clients sometimes presented their perception of the solution to a business problem rather than the problem itself. An example provided by expert P is the situation when the client suggests that their current software is inadequate in some regard and needed to be replaced but in fact, "*… the problem is not so much that the current system is not working but, as I've had in a number of cases, the fact that they're not using it properly. And so, the fix is not necessarily to throw what they've got away but actually change some of their processes*". In another example, a client described the problem as being that they needed a database however further investigation revealed the problem to be about document management. After students had their initial interview(s) expert P would encourage the students to consider the question "*what was the original problem specified by the client and now what is the real problem as a result of having interviewed the client?*"

Expert D described the importance of trying to frame the problem and requirements in business terms rather than in terms of solutions. "*Don't just grab that juicy low hanging fruit. It might not be the right one yet. You may need to do a bit more work to flesh out what the real problem is that needs to be solved. But if you said to me, "No, I need email" well there is your requirement. You really need it. But I talk to them about it. Often people will give you a requirement which is cleverly disguised as a solution.*" Not only do the students struggle with this but the difficulty is compounded by the client also not appreciating the difference the business problem and what they perceive to be a solution or alternatively not being clear themselves as to the nature of the problem. As expert D describes, "*I talked to them about the problem of having the client articulate their requirements in terms of what they believe the solution could be. So trying to dig a bit deeper and find out what the requirement really is. And often when the client sees it written down they say that is not quite my requirement. So validating with the client is something that I have pushed on them …*" His advice to students was to ask the sorts of questions that help to uncover the problem and requirements from the business perspective, *"… start talking about, "What is that you want? What is the problem that you need to solve?" You will get two things. One is you will get a more truthful requirement. You also get a better understanding of their overall business problem because that's what they're going to tell you.*" He continues in his description of questioning the client on their underlying business needs, *"… why are we doing that? Because we need to satisfy this high level requirement. It's the old what and how. At some point you have to pick a level and it may be that their requirement is that it shall be a piece of software that sits on the desktop and that's fine if that's really the requirement. But if it's not the requirement then find out what it is. You've got to go back one step. Try not to put the solution in there because you think it's the logical* *answer or way of satisfying the requirement so don't call that a requirement when it's not. .. Did they really ask me for a piece of software? Are they saying it has to be? What is your problem?*"

**A13 Students may not appreciate the patience and persistence that can be required to understand the problem and requirements.** It often takes several meetings with the client for students to obtain a reasonably satisfactory understanding of the problem and the client's overall requirements. Students often expect to obtain all the information and understanding they need for their project at the first meeting and are therefore a little disappointed when it is not achieved. Typically they express much more satisfaction after the second client meeting.

The expert supervisors are not supposed to attend client meetings so they are reliant on the students' description of what they had learnt. The expert supervisors in their discussions with the teams test whether the team has explored the client's problem and requirements to sufficient depth and breadth. If their description seems deficient or inconsistent then they would explore the issues and when needed, prompt the team to ask the client more questions, speak to other relevant people within the client organisation or research some relevant area and so on. For example expert P recalled telling one of his teams that, "*… you haven't really identified the requirements in some of the areas. You need to ask some more questions to find exactly what the client wants. And … to their credit they did that.*"

Expert P describes one team's interpretation of the development of the client's requirements as the client changing their mind however expert P perceived it differently, "*I remember thinking that this was not so much the client changing their requirements but that that particular group really hadn't got the whole story. Whether they hadn't asked the right questions or whether they hadn't had the opportunity, I'm not sure but I think they needed some things clarified.*"

Expert D mentions having significant discussions with all his teams about requirements and particularly regarding the quality of requirements and the support he gave in that area, "*How will you know when it's done? How are you going to measure that? Can you measure it? All those things. Yes, we had those discussions. They were fairly major discussions we had early on in the piece and definitely helped them there … they came back with requirements that weren't really requirements … … they came back with statements that were not measurable. They were just statements. They needed to be framed up.*"

5.2.3.3 Difficulty handling uncertainty

**A14 Some students have personal difficulty dealing with uncertainty.** All the experts were well experienced with the uncertainties involved in Information Systems projects and accepted that they simply had to deal with them in as best possible. As Expert G observed, "*there's always uncertainty and the whole point of going through an analysis is that you remove some of that uncertainty and it's going to be the same over all sorts of engagements*".

While students might understand at an intellectual level that IS projects change and evolve, they are unlikely to have experienced working in the "fog" generated by uncertainty particularly at the early stages of a project. Students varied considerably in their reactions to the uncertainties mentioned above with some demonstrating a great deal of frustration or anxiety. In a more extreme example, Expert P describes the reactions of one particular student who was quite distressed after the first client meeting, "*I had one group and the girl went into panic mode after the first meeting with the client. It was a good group. They were quite good students but she just went off the deep end in terms of "I don't know what they want; they don't know what they want"… she felt that the client was uncooperative which she saw that as being a barrier to success in the project*". This student had apparently assumed that the client would simply open up and provide a clear and concise description of their needs. But as expert P describes, "*There are so many of these things that will differ from client to client. You'll get one client who will pour everything out so you can't keep up. And another client it's like getting blood out of a stone. You have to ask the right questions.*" Expert P's response to the student was to reassure her that this was nothing unusual and to discuss an appropriate strategy for the next meeting with the client. This brought the student emotionally back on track and ready to continue the project in a better frame of mind.

**A15 Students may go into interviews with the client with the expectation that there is or should be a clearly defined problem, goals and set of requirements.** Expert G supervised one student with a client who was unsure precisely what she wanted and the student lamented, "*… about the frustrations of a client who kept changing her mind and would say one thing and change their thinking. And his comment was we should be vetting our projects better because … it caused all sorts of problems*". This attitude might be an extension of the experience with academic assignments in the Information Systems area which tend to be relatively prescriptive even to the point of providing a rubric and marking scheme. The idea that the clients' thinking about the project is not well thought out and is evolving or even changing dramatically can be something of a shock. There may also be the underlying idea that there is a problem and set of requirements there to be "discovered". The idea that projects can involve a creative process in which they can and should participate through helping the client to define the problem or opportunity and determine the scope and goals can be an unexpected or daunting experience.

**A16 An area in which students must be particularly proactive is with the task of gathering requirements.** While clients and other relevant stakeholders may be able to describe some of their requirements, they will require the knowledge and support of the students to identify clearly and precisely the full range of functional and non-functional (e.g. technical, legal, security, usability etc.) requirements that need to be considered before making recommendations. A team must attempt to make progress even when some issues are not entirely resolved. Expert G, "*you will never know absolutely everything and you can get into analysis paralysis. So this idea I need to find out something, I can't do anything until I found out this whereas at some point in time you've got to do something."* One team being supervised by expert G were particularly frustrated with their client who was particularly unhelpful, "*And the requirements were that we want something that does pretty much what they're using now does but we want other things as well but we're not quite certain what they are … there was frustration because they had difficulty getting the requirements, specific requirements out of the client so eventually they proposed some requirements*". In this case expert G had suggested, "*As an approach, if you can present a straw man it becomes a discussion point and you can pull it apart and it helps them clarify their thoughts*". This turned out to be a successful strategy. Clients need to be helped, prompted or advised using strategies that seem most appropriate to the client.

5.2.3.4 Difficulty in translating their existing knowledge to the problem domain

**A17 Students often struggled to apply their existing knowledge and skills to the problem domain.** Expert P stated, "*They don't know how to approach the problem identification. They don't seem to know how to approach getting requirements because they can't relate what they've learnt here to a new situation."* At another time, *"They understand the tools. If you say to them go away and do a process model… or draw context diagram or draw a workflow diagram, no problem … But how do they start, what sort of questions do they [ask]*". For expert P, while students had a repertoire of knowledge and skills that they could apply individually if given the appropriate problem, they did not know how to apply them out of their standard contexts and in a collective way to achieve a useful product.

Students can also struggle to translate even everyday knowledge into the problem domain. One team working with Expert G expressed their bafflement at the start of their project, "*we know nothing about this, we don't know what to ask them*". Expert G's response is that students often know more than they realise but have difficulty in transferring knowledge from other domains into the current one. Expert G provided this example of an interaction with students after an interview, "

> *[Students:] 'We've been asked about requirements for touchpads for booking rooms and things like that.'*
>
> *[Expert G:] And, talking it through [with them, I asked] 'What are the problems that you see?'*
>
> *[Students:] 'Oh we don't know anything about that.'*
>
> *[Expert G:] 'So you've got no experience with using touchpads?'*
>
> *[Students:] 'No, no'*
>
> *[Expert G:] 'Look you've all got phones that have touchscreens. How do you use them? What's good about that and what isn't good?'*
>
> *[Students] 'Oh yeah, yeah."*

Experts G's view was that most teams tend to have members who collectively have diverse knowledge and skills so there is potentially far more knowledge available to them as a team than they realise if they can utilize it.  However, this may not be easy, Expert G, "*trying to get them to think about it, it is like pulling teeth sometimes.*"

### 5.2.4 The Project Description

Getting to the point where the team can produce a project description that can be signed off by the client is a significant milestone.  It takes about four weeks in the 12 week projects for students to do all the work required. Expert P admits that, *"… it takes a while and it eats into the project time and I often say to the students, "while you're waiting for the sign off you can still be talking to the client about requirements and that sort of thing." That can be going on in the background. So you don't have to stop dead. But it is a significant point. In real terms [referring to real world projects] you're not going to proceed with the project until you've got a sign off.*"  Each team typically formally walks through their project description with the client and sometimes other stakeholders to validate and confirm their mutual understanding of the project. It is not an unusual situation for the client or other stakeholders to query aspects of the project description and in some cases request changes before signing off. Presenting the project description to the client keeps students honest in case, for example, students are redefining the scope towards their own interest or convenience. A team's supervisor will usually attend the formal walk-through as an observer and meet the client.

**A18 Students typically do not appreciate the care and precision with language that needs to be applied when writing the project description for the client's approval.**

Students can be relatively casual with the project description perhaps taking the view that the client can read "between the lines" and understands what was meant. Expert supervisors try to impress upon the teams that they should aim to produce a professional document. This includes thoroughly canvassing all the relevant issues, using clear and precise grammar, and a high quality of presentation and so on.

In commercial projects when the project description is signed off by the various participants it amounts to a legal contract. This previous experience makes the experts very sensitive to the wording of the project description. Although these student project descriptions are more akin to a statement of intent (and not binding contracts), students still need to clear and precise with what they write and they should only commit themselves to what they can reasonably deliver. For example expert G found that, "*The wording they use often could be used to commit them to something they can't deliver on, especially when you're just doing an analysis piece of work, you're just doing analysis and at the end of it you're just writing a report which enables them to move onto the next stage and they will often talk about having something like testing"*. Similarly, Expert P described telling one of his teams about the scope statement in the project description, "*you've got a statement saying we'll develop the system … But are you developing system? You're just working on the requirements. You've just agreed to develop the system.*" Another example was provided by expert G, "*The classic is they'll say, "I'm going to produce a prototype.*" After expert G discussed what they had really intended by using the word "prototype" Expert G's advice to the students was "*Don't use the word prototype, use design concepts*" since the word prototype could be construed to something far more elaborate. Similarly expert P states, "*the way you write the scope statement is critically important. For example, in an analytical project if you say we will be implementing a system … you are implying you are going to build it.*"

Teams are normally required to submit their project descriptions to the supervisor for discussion and review before submitting them to their client. Some students (incorrectly) believe their supervisor's feedback to be somewhat pedantic while other students (both local and international) can struggle to produce an adequate document especially if they have relatively weak writing skills.

According to expert P, putting together the project description is a good learning exercise, "*They learn an enormous amount from that. That words matter and also sets the scene that this is a real project because the client's got to sign it off."* and the effect can be that, *"they are in project mode rather than assignment mode*".

### 5.2.5 Researching potential solutions

**A19 Students are familiar and proficient with the Internet used as a general purpose research tool but can be oblivious or reluctant to explore other ways of researching and gathering information.** Expert D, "*I think they all know how to research. I think they know that they need to and they know how to and most of that "how to", let's face it, will be the Internet.*" and expert G thought that they were "*fairly good at researching but needed some direction*" either by the client or by their supervisor. Expert J for example stated about his teams, "*All I ever really got out of them was that they searched for it on the Internet*".

Working analysts, particularly in larger organisations, have other resources they can go to for advice within their organization; in the form of other professionals who include other experienced analysts, solution architects, subject matter experts and so on. "*You've got all this support behind you in [name of very large IT firm] if you need it. If you need support you just dial a number. You've got mentors.*" With regard to finding specific software, he describes how, "*We would have a list of products that we were supposed to use or typically I would ask some architect or experienced people there who had done a lot of research on products and stuff like that but even then some of their research was just on the net.*"

While students do not have the resources that would be available to analysts working in industry, the internet, powerful as it can be, is still limited and students should be aware of and pursue different avenues in their research. One particular project involved finding software for a non-profit organisation to support disabled people. Internet searching by the students was not particularly fruitful and in their meeting with their supervisor, expert D, they mentioned their frustration. Expert D recalls, "*I remember* *saying to them this is not the first organisation to have this problem so there will be other organisations that will have had this problem and solved it. So you might get a leg up and go and see what other people are doing*". In this particular case, students found similar organisations and in visiting them found that two of these organisations were using exactly the types of software that they were looking for with the added advantage that they could discuss their advantages and disadvantages with the users of the software. As reluctant as some students can be to look beyond the Internet sometimes they need to be encouraged or pushed to do so. Expert D, "*What other sources? That's what as we discussed earlier. For example, the peers, the industry peers. There's another source of information they haven't quite got.*"

The diligence with which students do their research can be related to whether they believe they already have the solution. For example, the team working with expert P had already decided the solution for their project before meeting the clients and their initial research was superficial. This was obvious to expert P, "*I think Team S's research options were narrow because they had already decided on the solution and so they didn't look at possible solutions.*" If students are solution focused, then there will be a tendency to do superficial research sufficient to minimally meet academic or client expectations.

**A20 Students are unsure about the criteria that need to be satisfied to gain credibility with the client for their recommendations or decisions.** Expert D did not rely on his own authority as an experienced analyst for justification but expected that he be able to demonstrate sufficient research and references to reliable sources to justify his advice or recommendation, "*It's more about due diligence. It's more about have I covered enough ground to back up what I'm saying here; credibility maybe? And usually you want to be able to point to some reason. It's not just me saying this, this is the accepted argument. For example, people will like to point to Gartner reports or the CIO of X said, "He thinks". It's not about what you think it's about what everybody else thinks. It gives you a level of credibility I suppose."* At another point, expert D describes the need for providing transparency of process to demonstrate credibility for any decision or recommendation made to the client, "*So have a clear visibility of your decision path. In the end, you want good structure, good argument [and] good reasons for selecting a product rightly or wrongly. And even if you're wrong in the end because there was something that you didn't know you've covered it off by assumptions or tied it directly to a requirement or something like that so tidy up by doing those things.*"

Expert D was concerned that as an analyst he needed to be able to substantiate any advice or recommendations reasonably convincingly, "*The missing one [question] there was perhaps, "have I got enough?" Have I got everything?*" When asked how he decided when he had done enough research his response was, "*That's a hard one. I guess it depends what the assignment is, but it's about do I have enough here that can I put my hand on my heart and say I've got enough evidence here to support my decision or my opinion or those sorts of things.*" The issue as he saw it was not just being able to provide evidence for a particular recommendation but also to be able to explain why other potential recommendations were less satisfactory and to demonstrate that he understood the overall context of the problem domain. "*Where I was heading is that if they didn't do that research to start with they can't speak with confidence about these other packages because their knowledge of the subject area is a bit flaky or there might be things about the subject area they don't even know they don't know yet. So they need to explore a little to make sure they understand enough about it so that they can frame up an argument or do further research or whatever. Eventually I think you'll get to a point where okay I think I know enough about this to now be able to have an opinion, do further research, make a decision rather than say, "I'm going to recommend product X and hope like hell the client doesn't give me too many hard questions because I don't really understand X too well or I don't understand really what it does or I really don't understand the problem well enough or not sure that X is even the right tool for some other reason.*"

**A21 Students should appreciate that they need to support the client in order to make satisfactory recommendation and decisions.** Making decisions in the area of information systems is very often about considering a number of potential options each of which will have their own advantages and disadvantages. However, the analyst needs the client to determine the degree of importance of advantages and disadvantages and this, according to, expert D can only occur if the client understands what is being presented. Expert D suggests, "*You're not going to be in a position most often … that you can provide that absolute expert opinion that this is exactly the one that you should have and nothing else should be considered because it's all about pros and cons. It's all about weightings, it's all about, "Well I do like that", "but I do like that", "whilst this has X, that's a lower priority I really want Y" so who's the one that gets to measure all that stuff? It's the client's view on this and you can add value there by explaining in non-technical terms perhaps why this feature is important, could be important to you* *that ultimately it's their decision if it is or not.*" So the analyst must keep up the dialogue with the client, present the information to the client in a way that they can understand and through that process arrive at a recommendation or decision with which the client can feel satisfied.

### 5.2.6 Final reports and presentations

**A22 Students were unsure about the required standard of work and features on which to focus in the final report or final presentation.** In the great majority of cases over the course of the project teams achieved something of significant value for their client. However, presenting their work in a clear, logical and coherent manner which satisfied the expectations of both the client and supervisors was not easy. The report or presentation had to be understandable to the client but also demonstrate that students had applied the skills and knowledge they should have acquired in their studies. As support, there was a lecture discussing how to go about developing their final report and another lecture on their presentation. Both lectures were geared specifically around what the client and the supervisors would be looking for and common mistakes made by previous teams and students. There were also exemplars of team reports available as a guide which some teams viewed and found helpful. Most, but not all, students had written reports and made presentations before but not with the volume of material that needed to be collated and few had experience in presenting this type of material to an audience comprising their client, stakeholders and supervisors.

Expert G had worked with two teams of very capable students each of whom had 10 months of industry experience prior to doing their project. They had little need for support at the early stages of their project, "*and I thought I could add little value here but towards the end it is where they started becoming a bit more, "what do we do now?" And presentations, taking them through that. So I think it was useful for them from that aspect, how to deal with the clients. Some of the other groups in the past, they really didn't understand managing the project, so my help was more in that area.*" These students still wanted support with understanding the client's perspective and how best to present their findings in a manner that the client could appreciate. The other experts had the same client focus. Most importantly, teams would need to demonstrate that they had understood the client's problem and requirements and had provided an appropriate and satisfactory solution.

**A23 Allowing draft reports and practice presentations and providing feedback appears to provide significant learning opportunities and improves quality of deliverables**. All the experts described helping students, to a larger or lesser degree, with shaping and polishing presentations and reports. They emphasized elements of critical thinking such as clarity, accuracy, logical reasoning, transparency of process and reliable evidence. There was also the expectation, where appropriate, that the relevant standard techniques and approaches had been adopted.

Teams were allowed to submit a draft report which the supervisor would read and provide feedback. Expert P, for example, explains, "*Now, I didn't edit it. I didn't rewrite it but I wrote comments such as I think you need to expand this, I think you've missed out, you need to add some stuff on your method to give credibility to the report, you haven't covered this topic et cetera, et cetera. … I probably created work for them. That's probably what I ended up doing saying this doesn't read very well, you need to edit this, this needs to be expanded because there's not enough detail in terms of what you did, you haven't analysed the alternative proposals against each other properly so go away and use some of the techniques used in [relevant unit of study]. So I became a directory in one sense, you need to do this you need to do that. In a normal assignment you probably wouldn't do that because then you would grade it and I would stop there.*"

Each team was allowed the opportunity of doing a practice presentation prior to their final presentation and getting feedback. This feedback related not only to the presentation's content but also to each student's presentation style and to the coordination of the team during the presentation. Sometimes serious problems have been detected and eliminated. For example, teams have launched into discussing the recommendations with little or no mention of the problem being solved. Another example is the presentation with slide after slide that loses the audience with technical details and jargon. Alternatively, some international students have been extremely anxious because they have never given a presentation of this type before and so the practice can help relieve some of that anxiety.

Anecdotal evidence from clients and independent audience members or academic suggests that there is a significant improvement in the overall quality of presentations and reports.

## 5.3 Project management

**A24 Students must guide their clients through a project process with which they haven't fully internalized.** While students are taught the ideas of project management they have not internalized the entire process. Some of the ideas are very basic such as having a clearly defined problem and concrete objectives achievable within a specific time frame and so on. If they unable to apply these ideas in a concrete situation they can resort to old habits.

One example was a team working on a business intelligence project. All the students were enthusiastic as was the client but as the weeks rolled by their supervisor was unable to get a clear explanation as to the project objectives and precisely what the team was expected to deliver. The team's explanation revolved around the idea that organizations needed to understand the importance of business intelligence and how it could be used effectively. The idea that they needed to work toward defining a specific problem or goal and a tangible product such as a research paper, a design, report, model etc. that they would deliver and could be assessed on at the end of project's time frame seemed to elude them. To an extent the client was the source of the difficulty because he would speak enthusiastically but always in terms of his general area of interest and the students would emerge from each meeting with him excited but again without a deliverable. In the end, it required a rather long meeting involving the client, team and supervisor to determine a specific goal and a deliverable which ultimately turned out to be an interesting and useful demonstration of the application of a business intelligence tool to a fictitious organization that the team created. Although this example could have been construed as failures of problem definition or client management, the most fundamental problem seems to be that the team didn't seem to able to step back and see that they were meant to be leading and executing a project with all the implications that the term "project" implies as opposed to having a series of interesting discussions with their client.

**A25 Students must learn to develop a more client centric attitude to the project**. The most significant difference that students are likely to have to deal with is the attitude change necessary because of the presence of the client. All the experts tried to get their teams to develop a client based approach and to focus on how best to help the client rather than treat the project just another assignment. Expert D for example spoke to each of his teams individually about the importance of the client, "*Try not to treat*

*this as an assignment that you've just got to get done. We all know at the end of the day that this is just another one that you going to tick off and move on to another subject or finish but you have a real client. They are investing time and effort. They have a real need and especially [one particular client's organisation]. They are absolutely excited about it and you can tell. And there were enough people that turned up at the meeting so they are interested. So there is an added responsibility so you should really focus on this and treat it as a real engagement. Now I told that same story to [leader of team T] … [The client] wants your opinion. He's not doing this just to waste his time and just to be a friend of Swinburne. He wants something out of this so you have a responsibility of delivering so treat it as a professional engagement first and as an assignment second.*"
Expert P discussed how the presence of the client required higher standards than would otherwise be applied, "*My argument is that this is going to a client … this is not just an assignment, in a sense it's selling Swinburne and so in a real situation the supervisor will vet [review] stuff before it goes out to the client and that's what I do*". Later, "*In a normal assignment you probably wouldn't do that because then you would grade it and I would stop there … [but] these things are going out to clients so I think they have to be up to a certain standard.*"
Not all students appreciated the extra layer of complexity created by the presence of the client. Expert D describes how some students view the client, "*'We have to do this assignment in order to pass the subject and not only that we have to deal with a client!' … There's a negative feeling towards the client almost. … 'There's another hoop I've got to jump through.'*" Of course, the key point of the Capstone projects is to prepare students for real world projects and that means learning how to deal with clients. For expert D, "*A real client is the thing that's made the difference. Otherwise it's all academic.*" Overall, the great majority of students did, in fact, come to treat the project as a real engagement and, "*were well aware of the client's needs and seem to be genuinely interested in solving them.*"
**A26 Students must embrace the idea that they must be more proactive and self-reliant in a variety of areas.** This is another attitudinal change in terms of project management. They must learn to drive the project in terms of planning, working with the client, setting standards, determining what to research and how much and so on rather than be passively expecting their client or supervisor to direct them. "*The thing that some of them have trouble with first is that thing … moving away from that thing they get with normal assignments where they are told exactly what to do. They now*

*have to plan themselves. They have to sit down and work out what they're going to do. They're not used to it but by the end, often I get in journal reflections students saying we learned how to deal with these kinds of situations; or we learnt how to deal with problems in the group; all those sorts of things. I think that's really positive.*" How well students adapt to this depends on the nature of the student and the project. Students who expect to follow a predefined set of steps are typically disappointed. Expert P, "*I tell them, you won't get a blueprint. There is no blueprint. Every project, there is a general process you go through but there is no blueprint. Every project is different*".

The feeling among the experts was that students needed to experience the problem and wrestle with it themselves before they stepped in. Expert P's belief was that, *"If you over supervise it you hinder the learning.*" Sometimes teams reach an impasse or look like being excessively delayed in which case the supervisor may have to take over temporarily, "*The worst-case scenario they're going round and round and round in circles and you've got to stop them going round that spiral thing and point them in the right direction because they want step one, step two, step three, which is a little bit disappointing because I try not to do that.*"

**A27 Students typically don't apply sophisticated project management techniques in their projects**. Expert G's observation was blunter, "*or often even very simple ones*". Students sometimes have to be instructed or pushed to do simple things such as develop and maintain a project plan, take minutes of meetings, produce action items lists or to maintain a repository of project data available to all team members . While these things do not always seem particularly important to students at the beginning of their project they become increasingly important as the project develops.

As has been mentioned elsewhere, students have worked on many group assignments earlier in their studies and having reached this final stage in their course the strategies they have employed have obviously been largely successful. One team stated to Expert P, "*We've all worked together before, we all know what each other can do, so we basically divvied up the work, went ahead and did it and got together when we needed to.*" The strategies previously adopted however may not scale up very well with capstone projects. Expert P believed that this team had missed the opportunity of using and experiencing something more sophisticated in terms of project management. Expert P, "*When I asked them how do you feel the project's going? I always got this sort of superficial answer, "Yeah, it's going fine. We've got it under control. Sometimes that works. I doubt whether that strategy would work on a large project and it especially* *wouldn't work on a project where you didn't, you know, you had people in the team you hadn't worked with before.*"

A team's underlying project management problems might become apparent as symptoms. For example, a particular team had on more than one occasion contacted their client via email around 6 o'clock in the afternoon requesting a meeting with their client the following morning. The client was very supportive of the team and, to her own inconvenience, did try to accommodate these last minute requests as best she could. What had been happening was revealed in the team-supervisor meetings when the team mentioned that the client was not always available when they requested a meeting. The supervisor's response to the team was that last minute requests for meetings was unreasonable given that the client had a full-time job and that many other clients would not have been so obliging.

Expert G suggested that last minute calls for meetings was probably symptomatic of project management problems. Expert G, "*Often that is an indication that they're not managing their own time well so they don't want to commit to a meeting with the client because they're concerned they won't hit their internal deadline and they won't have something ready to give to the client.*" In this case, the solution could be better planning on the part of the team which then might solve the problem.

The problem could be related to uncertainty among the team members about aspects of the project that they are working on. Expert G suggests that the team's rationale could go something like this, "*because there's uncertainty, I don't know how long it's going to take. What I'll do, I'll work on this and when it's nearly ready then we'll book the meeting.*" If this is the fundamental problem, then some possibilities are that the team might need to go back to the clients to resolve the uncertainty, or possibly do more research or it might mean the team needed to change their strategy regarding the deliverables and deadlines.

Another possible reason for teams requesting these last minute meetings suggested by expert G is that the team is concerned about letting the client down, "*They feel, 'Oh, no, I've let them down. I haven't been able to hit the deadline.'*" So, rather than raise the expectations of the client, they would prefer not to set them at all and so they wait until they have something to deliver. Expert G preferred that the team set reasonable targets and then work towards them, *"… if there's a reason, a good reason, why you can't or don't have something to deliver you can reschedule but people find that hard to do.*"

**A28 Teams need to be focused on producing tangible results toward their project deliverables**. Expert D stressed that the team had to demonstrate ongoing progress towards a successful project completion. Expert D, "*Well minutes are great. It's nice that they have meetings but I would like to see some results. Some tangible things … I'd like to see some documents produced. I'd like to see some milestones met or evidence that they are producing something; that they are on their way. So a draft of the [requirements] document. An understanding of the bits they're doing next. And how they're completing them. Minutes are minutes: they all turned up, they all had a good time but where's the [pause] show me [something tangible].*" Expert D was utilitarian in his approach to project management, "*The journey is important because that's where your standards and your disciplines come into play. But you only do that so you can get a good result at the end. In the end it's about the result. From the client's point of view he won't take an inferior deliverable and be satisfied because you had a great process. He's going to judge it by what you deliver. He would expect that the process will deliver it. And he would like to think that you arrived at it by a proper process. For him, the endgame is what you deliver ... But the other way to look at it is that if you get the process right it is likely that the deliverable will be good. But in the end from the customer's view he's paying for the deliverable.*" Expert D stresses the idea that the client is really only interested in the team's discipline and standards in as far as it is an indicator of the quality and credibility of the deliverables.

**A29 Students do not necessarily appreciate the difference between the client's interests regarding the project as opposed to their own internal concerns.** Overall, the experts have a well-developed sense for the client's perspective and interests as opposed to their own in the conduct of the project. They engage with the client on those aspects which they believe to be relevant and of interest to the client. This sense is less developed in students and at times they present the client with unnecessary details or issues. Examples of issues unlikely to be of interest to the client include the team's internal meeting schedule, working arrangements or internal risk management strategy. Expert G, "*I say project management is like running your own business. You've got two sets of books, the ones for the clients and the ones for you.*"

The corollary is that they may become concerned about or involved with client details or issues that are not related to their role as the project analysts. However, in this area there is no clear line of demarcation. One the one hand, all the experts warned students that they should not be telling the client how to run their business (as some students have done) and they should avoid becoming involved in the organizational politics and personality clashes. On the other hand, information systems are intimately tied to the business goals and processes. The experts certainly did see it as their role to suggest and advise the client about different possibilities and options that might influence or impact the client's business model or processes. Students should work *with* the client to explore the possibilities and options but not try to *tell* the client what they should do.

**A30 A weak aspect of teams' project management was with their management of their interaction with those others outside the team.** Expert G, for example, thought that, *"… the team time management skills tend to be good so they sit down and plan out when they are going to meet. Most of them do meet weekly in addition to the supervisor meetings. Where their time management isn't [strong] is where they're not considering their client and the people they've got to see.*" All the experts emphasized the importance of being proactive in working in with the client and other stakeholders and being aware of and working around their commitments. Expert G for example described developing a, *"… dialogue between you and the client, between the groups, and you've got to maintain that. They've [i.e. students] got to understand it is not their part or full-time job because if they had time to do this they would be doing it themselves. They've got other commitments… So what are the constraints on their time? You've got to find that out early on and follow that up. Has anything changed?*"

At the early stages of a project, one reason for developing and maintaining effective communication with the client is to ensure that the analyst and client both understand and agree on the problem being solved, requirements and project goals. As Expert D suggested to one of his teams that had not been communicating very effectively with their client, "*Well you don't want the client at the end to say, "Well that's all very well and that's fantastic and thanks for a great presentation. It would be brilliant except that's not really the problem. You didn't quite understand what I was talking about or I told you that I couldn't install X because we don't have Y.*" In another situation, Expert P described an interim presentation to the client in which the following occurred, "*She [the client] was quite switched on and when she turned around and said, "I'm a bit concerned because you haven't asked me about requirements." I was sitting there going, 'Oh, God!'*" The importance of the students validating their understanding of the problem, requirements and deliverables and so on with the client was strongly emphasized by all the experts.

When discussing their lack of communication with their client expert D explained to one of his teams, "*You've missed a lot of opportunities along the way to validate. And the other thing I said to them along the way is these people are busy they're running businesses or whatever they're doing don't be a pest. Bring it on early that you're going to do this and then do it. At the client meeting take the opportunity to validate what you're doing. You're educating yourself but you're also educating them. They [clients] might feel a little more comfortable if they know you're on track and they can start to see some progress. You're doing something. Great!*" Validation for expert D was obviously important for the team to confirm their own understanding and also important in communicating progress back to the client. Expert D, "*Make sure that you don't go charging down the wrong path. You might not have a clear understanding. You might think you know but you don't quite. Maybe your client didn't tell you what they thought they have told you so when you have something little bit tangible to show them get back with them and make sure you're on the right track. And it might unleash a whole lot of new requirements.*"

**A31 Students do not maintain consistent communication with their client throughout the duration of the project.** While students are often enthusiastic and diligent in communicating with their client at the earlier stages of the project, once they believe they understand what they are doing they tend to reduce or even cease communication as they do their research and work on their deliverables. Perhaps this is a reflection of students' previous work with assignments. Expert D's summation of the assignment experience with assignments, "*Come back when you're finished. If you've got any questions, I'll try to answer them.*" The experts, in contrast, expected to maintain regular communication with the client right through to the end of the project. Expert D describes his perspective of his relationship with his client to be that he is there to help the client to solve their problem. The client always owns the problem and should not expect to simply hand over the problem at some point to the analyst who returns with "the answer". For expert D, this meant that the analyst should be communicating and discussing their findings and understanding with the client and getting the client's opinions and perspectives in as far as the client can and is willing to be involved. Expert D stated, "*… the thing I told them about was the surprise at the end that you had done such a wonderful job and pretty much nothing else if you work pretty closely with the client to the extent that the client want you to work with them. If the client says go away, I don't want to see you again until the presentation well that would* *be a different story but that would probably be a bit of a rare event. Generally, you would want to get some sort of validation along the way otherwise how do you know?*" All the experts agreed that when it came to making any final recommendation there should be no surprises for the client because they should have been thoroughly discussed before any final presentation or report. As expert P stated, "*I try to explain this to my students that basically that the presentation shouldn't contain any surprises nor should the report because you should have discussed it with the client before you formalize anything.*" Expert J's experience of writing final reports in industry was that before any final report is actually finalized it would not only be reviewed by a team leader or supervisor but also, **"***gone to the client for their comments. They've come back with feedback. You've updated it and passed back to the client and who's then passed it onto someone else in their team who's come back with a whole lot of other comments that you've updated again. You've got it reviewed by your section and then it goes back again*". An important difference then between students and experts is the greater emphasis that experts place in engaging the client at every stage of the project.

### 5.3.1 Team dynamics

Expert P pointed out team dynamics is not easy for a supervisor to assess because most of the interaction occurs outside the view of the supervisor. However the expert supervisors were able to make some general observations and to describe a few situations when problems with the dynamics in the team created a situation in which the supervisor had to intervene in some way.

**A32 All expert supervisors found that most groups functioned quite well in that they were able to successfully complete the project with little or no obvious conflict between the group members.** Unlike the workplace, there is no pre-established hierarchy or roles among students and they rely on cooperation to create and maintain order and in the great majority of cases there are no serious problems. Expert D, for instance, stated, **"***I didn't see any and I didn't hear of any [conflict] in my three groups. And I haven't seen any reference to it in the journals.*" Similarly expert J observed no problems with his teams other than one team member who had missed a few team meetings but as he recalled, "*I spoke to the [team] manager and he said the issue is not turning up for meetings but he is still doing all the work. So he is working and to a satisfactory, as far as the manager is concerned, satisfactory level.*" Similarly, Expert G observed that there were some problems but nothing that required his intervention, "*There was friction but both of the groups worked. They had a common purpose so they tried to overcome that but you could still see that there was friction there.*" Not all members of a group will be as enthusiastic as others but often one or more team members will "step up" and take responsibility for driving the project to a successful conclusion. For example, expert P described such a situation, *"[Team D] had a member … who didn't do quite as much work as the others. He wasn't quite as enthusiastic. I think that team would have fallen by the wayside if it wasn't for B [another team member]. I think B steered them … he took the bull by the horns and took it seriously and brought people along with him in terms of the dynamics of that team."*

**A33 Leadership was the issue that seemed to be the most problematic and most often required support by the team supervisor.** Sometimes team members have expectations with regard to leadership style and responsibilities of the team leader. For example, the leader adopts a democratic style of leadership but other team members want a more directive leadership style or vice versa. In these types of situations, if the supervisor can become aware of the existing tension, he or she can discuss the different views about leadership style with the team members and often resolve the issue.

One problem encountered was that of two individuals effectively vying for leadership. Expert P related the situation of two female students N and K. Student N had shown interest in being the team leader and was chosen as such. Student K had declared that she was not interested in being team leader but, as expert P observed, had quite a strong dominating personality. *"… it was an interesting situation because [student N] came to see me two or three times and said, '[student K] is driving me crazy.' She is imposing her [ideas on us]. So I had to keep giving her strategies on how to deal with that situation because this domination, or dominant personality, was coming through wanting to take control. Well, it didn't happen in this situation.*" So, expert P was able to handle a situation by talking through the problem with the team leader and provide her with strategies for dealing with this situation and, it is hoped, similar situations in the future. Two people fighting for control can have consequences for the other team members. Expert P, *"… sometimes it creates dysfunctionality within the group because the other people don't know who to get their instructions from.*" The dysfunctionality within the team may not become obvious at the early stages of the project however, *"It might be at the end when they're trying to put things together."* At that point, a great deal of ill feeling may have been generated between team members and the supervisor may be limited in what they can do to repair the situation.

Expert D suggested that in some teams one person stands out as the “natural” or “obvious” project leader because of their experience or skills. From a learning perspective, the danger of a too dominant leader is that the other team members do not engage effectively with the project. Expert D thought he may have had such a situation with one team who had a dominant team leader, Team M, “*[The leader of team M] wasn’t here this week for some reason. But I had a good chat to the other two [team members] and these guys don't normally say a lot when [the leader] is around. But they seemed quite across what they were doing; quite comfortable with it. Whilst they have a clear project leader, the other team members, all two of them, seem to be adequately empowered to do things when [the leader] is not there. At least that's the way I see it. They showed me the work that they were doing and they seemed to be going through it. Again I haven't heard of any problems in that group”.*

A few teams adopt a consensus management style in which the team tends meets to work together on virtually all aspects of the project i.e. there is little delegation or separation of roles. Team N being supervised by expert D was one such team. They had a nominated leader but, “*There was no one in that group that, I will say, was an obvious leader because they had any particular skill or any perceived authority for example they had a job.*” This team appeared to function mostly by meeting and working together (with minimal delegation) and making decisions by consensus. “*More recently I'm wondering whether they're all functioning together that they're doing everything together rather than delegating. I'm not quite sure on that one. … [on the teams organization:] in our last conversation they seemed to have a reasonable understanding of what they’re doing.*” At another point expert D says, “*I suspect that that was going on a bit because when I spoke to them they would all chip in equally. There didn't seem to be a management.*” This consensus management style certainly kept all team members engaged in all aspects of their project and so was a good learning experience from that perspective. However, expert D felt some unease with this strategy as it was very time consuming and not a strategy that would “scale up”. In these cases, the experts would typically keep an eye on the team and provide advice on more effective ways to manage and operate if problems appeared.

**A34 There were some team members who others found unpleasant or difficult to work with and supervisors would often be asked for advice on how to cope.**

Consider this example given by expert P, “*One was with two girls and the guy and I got them in and I said, “Look we’ve all got to work together.” The girls I told them this is a*

*good learning experience for you. I tried to couch it in positive terms because they were all ready to throw it in. They had had enough of this guy. He was arrogant he was whatever. And I said, 'Hey, welcome to the real world. There is one in every team and if you can learn to deal with this situation were going to be really well equipped for when you go out into industry.' And they both took it on board. They didn't like it but they saw it through. They could see the positive in how to deal with it.*" In another case, there was an ambitious student who regarded the rest of the team as something of an impediment to his goals. Expert P recalls the particular student, *"… what he said to me, was, 'I don't care what happens to the other people all I want is a high distinction. That's my objective. I don't care whether they coast along with me or whatever.'*"
When they become aware of conflicts the supervisor normally begins by discussing the situation with those who expressed concern and discuss how they might be able to deal with the situation themselves. Failing that, the supervisor may need to engage more directly depending on the nature of the situation.

Beyond allocating roles and distributing tasks within their team students showed little interest in trying to understand the internal dynamics within their teams especially if the team appeared to be working satisfactorily. If problems occurred either e.g. due to personality clashes or managing and dealing with the project they typically handled in on an intuitive and ad hoc way. All the experts showed great awareness of the importance of having well-functioning team dynamics and personal interactions. Their ability to handle problems as they arose with their teams and the client and other stakeholders demonstrated their skill and experience in this area. However, of the experts, only expert G, possibly encouraged by his current role as a project manager, demonstrated knowledge of theories and models of personality types, relationships and teamwork and actively used them when discussing team work and personality both in the work environment and with regard to his student teams.

**A35 Arguments about whether there was fair contribution of work by each of the team members were not uncommon.** Those who believed that they had done significantly more work than other team members were often frustrated that other team members would unfairly benefit. Measuring contribution is very difficult. Most students believe that relative total time spent on the project is not a sufficient reflection of contribution (assuming students were totally honest about time spent working on the project) and believe that the type and quality of the contribution are important determinants. This results in very subjective and intuitive judgments about how much they and others have contributed to the project which leads to argument (Farrell et al., 2012). Expert P, "*My best team is still arguing about how much work people have done. I finally had to send them an email, 'Folks, let's stop the arguing and get the report done and then if you want to have a post-mortem after it's all over I'm happy to facilitate that but let's stop arguing.' So there are some issues there.*"

Some students in previous group assignment work have been able to get away with letting others do most of the work with little or no consequences. . Alternatively, expert P, "*I think they're still tied up in this assignment mode. You do this assignment and I'll do the next one sort of thing. … They get to the project and they realise they can't do that because there's too much work.*" The project however is of such a scale that there is little room for "free riding" in small groups of only three to four students. If this is picked up at the early stages of the project and students can see that there will be negative consequences for free riding most students will consequently contribute more effectively (Farrell et al., 2012).

### 5.3.2 Managing the client

**A36 An area of project management on which all the experts placed a lot of emphasis was that of "managing the client".** Managing the client is the consultant's process of guiding, advising and supporting the client with their problems towards a resolution with which the client would be satisfied. Underpinning this process for all the experts were the values of honesty and integrity, a genuine desire to help the client and a dedication to high standards in their profession. The experts did not see their role as simply giving the client what they wanted but genuinely aimed for the best possible outcome for the client. In order to do this there needs to be an effective working relationship developed with the client.

Expert G describes a common beginning with projects, "*At the start of these assignments [meaning projects] often there is, "Oh, they told us we've got to do this. We've got to do that." No, I say. You've got to discuss with them what's achievable and it's really about taking them from that child role into an adult.*" In another situation a team supervised by expert G, *"… went into an organisation and the organisation thought they were going to be delivering, revamping their whole SharePoint system. And they came away from this, they didn't say anything about this in the meeting, and they came to me [and said], "What do we do? When can we deliver the revised*

*SharePoint system?" And I said, "You've got to say, no that's not what we're doing. Just because that's what they want isn't what can be delivered."*

Expert P describes a situation in which the client introduced a new dimension to the project which students felt unable to question or refuse. Expert P describes how he stepped in to handle it and provided an example to his students, "… *we had an interim presentation where they had to present their progress to the client, and the client introduced a totally new concept which hadn't been articulated before and the group had no idea how to handle it and I showed them how to handle it. In their journal, it came out [paraphrasing from a student's journal], 'Thank goodness that [their supervisor] was there because we didn't know what to do. …' It is about managing the client. …You show them diplomacy … Things come up … and it's an unusual situation. Something they've never encountered before so you can't say "go for it" – you've got to this step in and say this is how you manage it. After that situation basically what I did was I said to the client, "This is really interesting stuff. Can you make a note of it? But of course that is further down the track. We've got to walk before we can run." Then he [the client] was telling me that's three years down the track. Okay, I've managed the client. Afterwards, we had a session and I explained what happened and what I did and how you can manage your client without being aggressive or too assertive.*"

Occasionally, a student may display a condescending or superior attitude toward the client. Expert P describes one such student's approach to dealing with clients, *"[The team leader of team S] made this absolutely inane statement about something to do with clients along the lines of, 'We have to tell the client what they want … we've talked to the client but sometimes you have to tell the client what they need.' And that's true to some extent. You have to guide your client. You've got to manage your client but the way it was couched was, 'It's our job to tell them what the requirements are.' And I remember looking at him in the face and saying, 'I totally disagree with you.' He was quite surprised. He needed a kick up the backside because this whole process has to be consultative. Yes I accept that sometimes clients, you need to open some doors, to give them ideas so they can think a bit laterally … You don't say, 'This is what we've decided you need.'"*

**A37 On the whole students established productive relationships with their clients as the project progressed although often with shaky beginnings because they lacked an appropriate model or philosophy to guide the client-consultant relationship.** Expert G summaries his observations of the client/student interaction, "*In* *general, I would say over the couple of years I've been doing this now the students are pretty good at handling the clients … once they developed an understanding of the relationship between themselves and their client. A lot of them go into it, because all they've really experienced is an hierarchical relationship, whereby your reporting into someone, they're your boss, they're your parent, they're your teacher. They direct you and what you do and you go off and do it. … Actually it should be almost a relationship of equals.*" So for expert G the first hurdle that many students faced was moving away from their previous model of personal interaction based on hierarchical relationships to another type of relationship based more on the partnership model. Plant (1989) suggests, "*Above all a project manager is judged by the question 'Is the client satisfied?'… The most effective relationship between the project manager and a senior client is best described by the word 'partnership'. It implies people working together, mutual respect, synergy, risk sharing and shared goals. It implies the talents of the project manager are not subordinated by the power or authority of the client. Building such a relationship depends above all on the professionalism of the project manager and his personal interaction with the client.*"

**A 38 The concept of managing clients' expectations was mentioned by all the experts as an important aspect of managing the client.** This is a matter of aligning the client and the consultant with what can reasonably be delivered. This requires that the students have the confidence to negotiate with the client and not submit to a client's requests or be held to assumptions which are unreasonable. As expert G advised his students to do with their clients, "*You've got to manage their expectations and understanding of what you can deliver. You've only got 12 weeks to work on a project so you've got to [clarify] the constraints on your time as well as their time.*" This should occur as students discuss the project with the client, expert D, "*validation, managing scope … rolls up into managing expectations*". If students do not tell the client that their expectations are too high or if they simply ignore some of the requirements then, even though the students may have done an otherwise satisfactory job, as expert P mentions, "*the client will believe that the project is a failure because you haven't done what they wanted*" Similarly expert G explains that not meeting the client's expectations also erodes the client's trust in the team because the client believes the team has made a commitment to the client which the team has not delivered, "*Where it's less forgiving is when you make a commitment and don't hit it.*" Even when the client and the team agree on reasonable goals then the responsibilities of the parties to achieve these goals need to be understood, **“***How do you deliver on the promise? In a work environment a promise is often conditional so you make a commitment to do something but it’s often dependent on something else happening. So you’ll promise to deliver something in three months’ time on the condition that the scope doesn’t change. So you’re quite happy to make that promise but you have to make the client or the sponsor understand that they have a responsibility.”* This requires students to make explicit the underlying assumptions and to have the confidence to express any obligations that need to be met by the client although expressing these obligations may well be difficult for students who are used to meeting obligations rather than imposing them.

**A39 Students face the problem that they may not be taken very seriously by their client even when their advice is no different that would be expressed by one of the experts.** As expert J suggested, students do not have “*that gravitas that comes from some older type person with authority.*” A situation which illustrates this is one with a rather persistent client who wanted the team of students being supervised by expert J to provide a cost estimate for a solution to his problem. As expert J described “*The client … every meeting, kept asking for cost estimates. They [the students] kept on asking what do we do, what do we do? … being young and inexperienced then their message didn't have enough weight …: I told them exactly what to say. But it still kept on coming back. So when they had their presentation I said it. That it wasn't appropriate of the students to be doing estimates. This is not about estimates it is about requirements analysis and they [client and other stakeholders] all looked at me and said okay.*” In the absence of much “inherited” trust that that comes from perceived authority (i.e. age, status, title, working for a recognized firm etc.), the students can only demonstrate the knowledge and skills that will, hopefully, earn the trust of their client so that they will be taken seriously. In cases where a difficult situation arises and the client refuses to take the student team seriously, it may require that the supervisor intervene. In extreme cases, clients have been so unreasonable or difficult the project has had to be aborted.

**A40 As novices, students may not know how to or be confident enough to defer difficult questions or requests from the client.** Expert J suggests some techniques he used as an analyst to defer questions or requests such the one regarding a cost estimate for a solution, “*Typically at [a large consulting firm], I would have hid behind, because it is a large structure, I would have hid behind my manager. First you say you haven't done the requirements of course so it's pretty hard to give an estimate. … And* *furthermore the actual estimates will never be done by the analyst, they will be done by the appropriate management person in the organisation. That's typically what happens. You might have some input into it because I have a lot of input into certain spreadsheet tools".* For expert D, simple honesty that they don't have the answer and would get back to them is typically the best response. Given the importance that the experts placed on developing and maintaining the client's trust it is not surprising that being honest was seen as so important.

## 5.4 The supervision process

### 5.4.1 The supervisor role and project control

Some assumptions about the capstone project are that students should take control, make their own decisions and be allowed to make mistakes while watched over and guided by their supervisors. All the experts adopted a "light touch" approach by advising, prompting, suggesting and empowering students to handle their own problems and difficult situations. The major role for the supervisor is to help bring out ideas, to question and to present students with different perspectives and viewpoints. Expert P suggests, *"… at the end of the day, how do you learn? You learn from making mistakes; from difficult interactions or from difficult people in the team … I want them to experience it otherwise it becomes like a normal assignment."*

Expert P would try to throw back problems posed by students back to the students to solve where possible, "*I've passed it back to the student to solve it. It's part of the process. Now I say if we can't solve it we'll escalate it to the next stage and we'll have a meeting and will go through exactly what each person [is doing] and I'll say, "Sorry, but that's not enough". I think these projects are as much about learning as they are about achieving the end result. … If you over supervise it you hinder the learning.*" At another point he states, *"I'm not saying you throw them out in the deep end without any strategies, definitely not. We talk about, before they go out and talk to the client; we talk about the project and talk about the sorts of things we ought to do before the first client interaction. They get advice but they don't get a blueprint*". Similarly, expert D would also throw back work to students but still be prepared to provide feedback on their efforts, "*They asked me originally about the report format. I said that it was up to you to come up with something. I'm not here to tell you how to do it. I'm just here to help you to think it through.*"

The expert supervisors only took control in situations such as a team significantly going off the rails or preventing them making a major misstep or in situations where only the expert could exert the necessary authority to achieve some desired result.

**S1 Supervisors believed that teams should take control of their projects and be allowed to make mistakes in order to learn from those mistakes.**

### 5.4.2 Standards and assessment

Students are often unsure about what constitute appropriate standards as they work on their projects. Although standards are discussed and described in lectures and provided in documents in the subject website, students preferred direct advice from their supervisor, "*Even though they've read what's on Blackboard or whatever, when it comes to something like presentations they keep on asking me what should be in it…. They still want reassurance.*" This might be because the supervisor's advice appears more authoritative, or trustworthy or contextually relevant than the other sources. Certainly, the expert supervisors should guide their students towards achieving appropriate professional standards. To do otherwise would make it pointless to have experts as supervisors.

Translating assessments into an academic grade required support in the form of clear marking guidelines and exemplars. This need was highlighted by some pertinent comments by two of the experts (J and G) regarding the correspondence between professional standards and the academic standards that students needed to achieve. As expert J put it, "*Yes, that's the professional standard but what's the standard for Swinburne?*" On a similar vein expert G also expressed the similar difficulty, "*Am I marking it too highly? Am I marking them too harshly? I don't have any sense of how that's going.*" (g2, 146) Expert G also suggested that objectivity was also a potential problem, *"… as the supervisor marking all their assignments there is a conflict of interest.… Because you're coaching and advising them on what they should be doing you can find yourself in the position in writing a report [where you say], "You need to do this. You need to do that." If they deliver a report at the end in which you have been intimately involved in the evolution of that, how do you maintain that objectivity?*"

The approach taken in this study was that assessment items were broken down into minor and major assessments. With minor items of assessment (e.g. items individually worth 5% or less out of the total score 100% available) supervisors were provided with rubrics and allowed to use their own judgment when applying the guidelines. When it came to major items of assessment such as a final presentation or report, these were reviewed and assessed by the team's supervisor and then by at least one other person who was a supervisor with significant academic experience in assessing capstone projects. Having the direct supervisor assessing work was important so as to provide an insight into the difficulties that the team may have encountered that may not be apparent to other assessors. However, the supervisors' comments indicated that more work in this area was required.

Every project is unique and standards are established as much by experience and precedents as much as by rules. In the case of written work such as final reports there are precedents available in pool containing a wide range of reports that have been previously reviewed and graded. These are available to both supervisors and students.

**S2 Experts need support in assessing and grading project work for academic purposes from their academic institution.**

### 5.4.3 Making things visible through discussion

A very important aspect of the cognitive apprentice model is that students and their supervisors articulate what they understand about the project and the relevant knowledge domains, their reasoning and strategies when making choices and processes they have used as they work (Collins et al., 1991). The supervisor's typical meeting with students often revolves around asking what the team is doing, posing questions, suggesting different ways of looking at things or responding to problems. Expert P, describes one scenario, "*… they'll tell me a problem they've had. The client just yelled at us. Okay that's all right, this happens. Welcome to the real world. Maybe you could try doing this. Have you tried doing this? Have you thought about the reason why they're going like that; [maybe] it's all about a power struggle?*" Responding to problems posed by the team or seeing potential issues and then discussing these but then leaving it to the team to make their own decisions and take appropriate action would seem to be in keeping with the spirit of "making things visible".

Students may not be naturally very talkative or reflective or they may be so focused on their own goals that they might see discussion beyond solving an immediate problem as a waste of time. It was not unusual for supervisors to find responses from students to be quite perfunctory. Expert D*, "How is everything going? Yep everything is good." "Give me an update." So I get an update. And then I say "Are there any issues? Are there any problems?" "No, everything is good." So they're thinking deadline, deadline, deadline.*

*I'm thinking … what are you thinking?"* Expert P had similar experiences, "*When I asked them how do you feel the project's going? I always got this sort of superficial answer, "Yeah, it's going fine. We've got it under control.""* From the students' perspective, some students might believe that asking questions or getting advice indicates lack of independence or that they don't know what they are doing. Expert D, "*The supervisor will think I'm doing a great job if I don't ask any questions and just do it. That could be what they're thinking. You don't want to be running to your boss or supervisor at work every 5 min. They'll get the idea that you don't know what you're doing.*" Alternatively, expert P found teams avoided engaging in discussion because they don't know what they are doing or for lack of progress, "*…in the meetings that we have, the team that is not working well is not really discussing the problems. You ask them questions. For example how is the project going? It's going fine. Okay tell me a bit more … The good groups tend to want to get your opinion. What do you think about this? Or would you think we should be doing this? Or can you give us guidance in terms of the direction we should take. The groups that are fairly weak, you have to extract this sort of information out of them. And it's interesting, I don't think it's a methodology … Some of its intuitive. You get a feeling that the group is not functioning properly. Alternatively they haven't done a great deal of work. So what I'll say is show me what you've done. Oh, we haven't got really much to show. So the truth's coming out.*" Experts D and P demonstrated a great deal of reflection about the discussion and feedback process. Expert D, "*In my own mind I was quite clear on what I wanted to do whether I succeeded in doing it. I did find myself sometimes telling them how to do things but I was always conscious, but sometimes after the fact, that I should be trying to lead them to a conclusion rather than just giving it to them. Occasionally I would throw one in. Since the e-mail discussion with [the leader of team T] I've probably been more aware of that. Trying to make the intention of my role more visible and trying to engage them a bit more.*" With teams that were difficult to engage in discussion expert P suggested that he might insist that students provide documents for meetings such as plans, team meeting minutes, interview questions etc. which could then form the basis for further discussion and feedback. Teams with little concrete output and few questions were warning signs of possible lack of progress. Expert P, for example, reviews team meeting minutes before his meeting with his team, "*I see those before each of the supervisor meetings and that gives me an idea of the sort of work they're doing … The team that is not doing well typically is a team that's is not meeting regularly.*" Another signpost mentioned by expert P was the project plan or schedule which teams are expected to maintain. If not updated periodically, it might signal problems but expert P also warned that students were notoriously poor with their plans, *"there is probably an element of things that are unreal particularly in terms of the time allocated to the various tasks. So to use that as a monitoring tool is probably a little bit tricky but I do that sometimes.*"

Expert D, after experiencing a misunderstanding of the supervisor role with the leader of Team T, reassessed his interaction with his students, *"[It] has made me think more about playing the adviser role than perhaps I was. So I'm more conscious now although I've been aware that's what I'm trying to do. I've tried since then to engage them more on that level of, "What are you thinking about?" I'm probably doing that more consciously now.*" Expert D considered several possible strategies to engage students, for example, "*Maybe one way to put it is okay you've told me in your group that you've got a project manager, you've got a business analyst and you've got a whatever, whatever. Now individually you might want to treat the adviser as perhaps a senior project manager, as a senior business analyst or senior whatever and be able to run, just try to run some ideas by , get some advice; those sorts of things. Collectively as a group you might engage as someone else to bounce some ideas off. You could do role specific things.… We would all do that. I see developers at work that go to our senior developer and say, "I'm thinking about this, what do you think?" Then as a group when they are putting it all together, outside the context of individual roles, they can collectively include me in the discussions and think out loud about why they're doing things. If they understand that's what it's about then they might want to include me.*"

Supervisors can sometimes be lulled into thinking that a team is progressing well when in fact it is not. One team with Expert P appeared to be saying all the right things and asking all the right questions and so reassured him that everything had been covered satisfactorily prior to an interim client presentation. However, in the presentation the client expressed her concern that the team had not made any significant effort to understand her requirements. Expert P was surprised and, *"… we had a long talk after that. So it made me realise just how far behind and how much guidance they really did need.*" After that event expert P demanded to see concrete documentary evidence of progress from that team rather than rely so much on their discussions.

**S3 Making things visible through discussion does not necessarily come easily to students or supervisors and needs to be worked on.**

**S4 There were a variety of strategies for encouraging discussion and feedback adopted by the experts such as the types of questions asked and questioning style, role playing, using documents such meeting minutes, interview notes, reports etc. as the basis for "making things visible".**

## 5.5 Chapter Summary

The following is the list of findings from the analyst interviews describing differences between the students and expert analysts:

A1. Students tend to believe that the original project brief will be an accurate description of the project.

A2. Students tend to believe that the project brief is not negotiable.

A3. Students often do not appreciate the importance of doing background research and becoming familiar with the problem domain.

A4. The lack of awareness or appreciation of the need to truly understand the problem within its context can lead to students prematurely deciding on a solution and thereafter being "solution focused".

A5. The strategy sometimes adopted by students of working backwards from the deliverables or objectives stated by the client in the project brief can lead to being "solution focused".

A6. Students will tend to make assumptions about various aspects of the project and then overcommit themselves down a particular path.

A7. Students do not appreciate the need to test their assumptions nor are they necessarily aware that they have made them.

A8. Many students have a relatively poor strategy in terms of asking questions.

A9. Students typically don't have a holistic view of a project and don't necessarily foresee the consequences of information obtained or decisions made on other aspects of a project.

A10. Students may not clearly understand the analyst role they are playing within the projects.

A11. Students can have difficulty managing the client interview so that they can satisfactorily achieve their goals.

A12. Students often struggled to determine the underlying business problem that needed to be solved.

A13. Students may not appreciate the patience and persistence that can be required to understand the problem and requirements

A14. Some students have personal difficulty dealing with uncertainty.

A15. Students may go into interviews with the client with the expectation that there is or should be a clearly defined problem, goals and set of requirements.

A16. An area in which students must be particularly proactive is with the task of gathering requirements.

A17. Students often struggled to apply their existing knowledge and skills to the problem domain.

A18. Students typically do not appreciate the care and precision with language that needs to be applied when writing the project description for the client’s approval.

A19. Students are familiar and proficient with the Internet used as a general purpose research tool but can be oblivious or reluctant to explore other ways of researching and gathering information.

A20. Students are unsure about the criteria that need to be satisfied to gain credibility with the client for their recommendations or decisions.

A21. Students should appreciate that they need to support the client in order to make satisfactory recommendation and decisions.

A22. Students were unsure about the required standard of work and features on which to focus in the final report or final presentation.

A23. Allowing draft reports and practice presentations and providing feedback appears to provide significant learning opportunities and improves quality of deliverables.

A24. Students must guide their clients through a project process with which they haven’t fully internalized.

A25. Students must learn to develop a more client centric attitude to the project.

A26. Students must embrace the idea that they must be more proactive and self-reliant in a variety of areas.

A27. Students typically don’t apply sophisticated project management techniques in their projects.

A28. Teams need to be focused on producing tangible results toward their project deliverables.

A29. Students do not necessarily appreciate the difference between the client’s interests regarding the project as opposed to their own internal concerns.

A30. A weak aspect of teams' project management was with their management of their interaction with those others outside the team.

A31. Students do not maintain consistent communication with their client throughout the duration of the project.

A32. All expert supervisors found that most groups functioned quite well in that they were able to successfully complete the project with little or no obvious conflict between the group members.

A33. Leadership was the issue that seemed to be the most problematic and most often required support by the team supervisor.

A34. There were some team members who others found unpleasant or difficult to work with and supervisors would often be asked for advice on how to cope.

A35. Arguments about whether there was fair contribution of work by each of the team members were not uncommon.

A36. An area of project management on which all the experts placed a lot of emphasis was that of "managing the client".

A37. On the whole students established productive relationships with their clients as the project progressed although often with shaky beginnings because they lacked an appropriate model or philosophy to guide the client-consultant relationship.

A38. The concept of managing clients' expectations was mentioned by all the experts as an important aspect of managing the client.

A39. Students face the problem that they may not be taken very seriously by their client even when their advice is no different that would be expressed by one of the experts.

A40. As novices, students may not know how to or be confident enough to defer difficult questions or requests from the client.

The following findings relate to the supervision process:

S1 Supervisors believed that teams should take control of their projects and be allowed to make mistakes in order to learn from those mistakes.

S2 Experts need support in assessing and grading project work for academic purposes from their academic institution.

S3 Making things visible through discussion does not necessarily come easily to students or supervisors and needs to be worked on.

S4 There were a variety of strategies for encouraging discussion and feedback adopted by the experts such as the types of questions asked and questioning style, role playing, using documents such as meeting minutes, interview notes, reports etc. as the basis for “making things visible”.

The next chapter provides an analysis and summary of findings of the students’ journals. This provides a students’ perspective regarding their project experience and complements the findings from the analysts’ interviews.

# 6 STUDENT JOURNAL ANALYSIS

## 6.1 Introduction

In the previous chapter the views of the expert supervisors were analysed and discussed. This provided the supervisors' perspectives and interpretations of the project and how they perceived students' handling of their projects. In this chapter the view now turns to how the students perceived the project, the issues they faced and their experiences with their supervisors. To obtain this information the students were asked to respond to sets of questions at three different points in the project approximately one third of the way through the project, two thirds of the way through and at the completion of the project. These responses were obtained through semi-structured journals. They were described as journals in that students gave their ideas and opinions about the project at the three different points in time while the term semi-structured referred to the idea that students were asked to respond to sets of open ended questions. The questions were chosen so that students were required to think quite broadly rather only what they perceived. This approach probably took them into areas outside their normal "comfort zone". These questions were mostly targeted on thematic issues of interest in this research but a few questions also allowed them to discuss any issue they found relevant at the time.

Students' responses to the journals were analysed to determine the concepts that students raised and this chapter provides a summary of the responses. When responding to a particular thematic issue, students were free to interpret the question or questions and answer in as much detail as they were willing or felt able. Students were simply asked to provide a response of at least 30 words to each question (or question set) which in the great majority of cases they did. At times, students might misinterpret a question or not respond to it in a very meaningful way. This was the risk in asking open-ended questions, but the advantage was that students responded naturally and sometimes in ways which could not have been foreseen.

The students could have been considered simply as one homogenous group but a significant differentiating factor among the students was that there were undergraduate or postgraduate students. The postgraduate students were on average a little older and most were from overseas studying Australia. On the other hand, many of the undergraduate students would have undertaken some industry based learning in areas relevant to Information Systems or information technology for several months as part of their course. Although the analysis was conducted across all students as a whole, the analysis is presented on the basis of undergraduate and postgraduate groups with the proportion of students who responded with each particular theme in each group determined. Understanding the broad differences in background between the two cohorts might provide the reader with some insights into the differences in responses between the cohorts.

The discussion below is divided into three major sections each corresponding to one of the three journals to which students were asked to respond. They appear in the chronological order that they were submitted so the sense of progression through the project is maintained. Within each section the introduction describes the stage of the project at which the journal would have been submitted and the activities that students would have undertaken within the period that the journal covers. After the introduction, each subsection corresponds to a question (sometimes two questions together) which corresponds to an issue that students were asked to discuss. Each subsection contains a very brief summation of the students' responses which is then followed by a more detailed summary. Because of the large volume of information produced, the detailed analyses were placed in Appendix C. These appendices contain the questions to which students responded, the description of the purpose of the questions, a detailed analysis of responses together with relevant quotes from students. Where appropriate, graphs are provided which summarise the percentage of students who responded with a particular concept and with the percentage of students who mentioned both one concept and another mentioned concept. Some quotes from students are provided within this chapter but many more quotes can be found in the detailed description in Appendix C.

To make the very brief summaries at the start more readable and less “dry” the percentage response figures were omitted and more intuitive words such as few, some, many etc. were used. To forewarn the reader the following terminology has been adopted: “few” indicates that 10% to 19% of students responded in this way; “some” indicates 20-29%; “many” indicates 30-45%; “half” indicates 46-54%; “most” indicates 55-69%; “great majority” indicates 70-79% and “nearly all” indicates 80-99%.

## 6.2 Journal 1

### 6.2.1 Introduction

This journal was required to be submitted approximately a third of the way through the project i.e. around the fifth week of the 12 week project. By then, teams had been through two long interview sessions with the client and other stakeholders each lasting around one and a half hours so that they could understand the problem, its context, the clients’ aims and the project scope. The first interview was a combined one with all teams allowed to ask questions of the client and other stakeholders who attended until they had exhausted their questions. The second interview time was a set of one-on-one interviews with the client and other stakeholders in which teams could ask their questions directly to the stakeholders as the stakeholders worked their way around from team to team. By the time of writing the journal, students would also have had at least three weekly meetings with their expert supervisors during that time.

The analysis of results is presented in the form of a one, two or three sentence summary of the results based around the journal questions that students answered. The detailed analysis of the journal is provided in Appendix C and this breaks the results down by undergraduates and postgraduates with percentages of students who provided a particular response. In order to keep this chapter to a more manageable size, responses given by very small proportions of students are typically not mentioned here. Often, in referring to undergraduates and postgraduates the acronyms UG and PG are used respectively. Detailed results can be found in Appendix C Journal 1 Analysis.

## 6.2.2 Results for Journal 1

### 6.2.2.1 Question 1 The client and the workplace

**1.1 The great majority of students did not show much interest in understanding their client or developing a relationship with their client.**

On the whole all students appeared to have little direct interest in or knowledge about the people they were interviewing (not even mentioning, in most cases, names and job roles). Only one student (a postgraduate student) correctly and fully named all those interviewed together with their job titles. 50% of postgraduates attempted to describe the clients' emotional attitudes to the project compared to 20% of undergraduates. Clients' attitudes were described in terms such as interested, enthusiastic, helpful, supportive, and serious and so on.

**1.2 The great majority of students did not appear to consider workplace culture or how it might affect their project.**

Overall, students did not appear to engage with the concept of workplace culture. One third of all students in both undergraduates and postgraduate groups made no attempt at all. Undergraduates discussed the importance of understanding workplace culture and cultural change but only a third or so of undergraduates students (38%) attempted to describe the existing culture, typically in a word or two using terms such as "formal", "professional", "organised" and so on. Of the latter group only one student attempted any serious analysis. Postgraduates engaged with this theme significantly less than undergraduates at both a theoretical and concrete level; this might possibly because postgraduates are less likely to have studied this topic in the course of their studies.

### 6.2.2.2 Question 2 Interview and its success

**1.3 Nearly all students believed that their first two interviews were successful with the second interview regarded as more successful. Having total control of the questioning of clients seemed to be quite important to some students in determining their satisfaction with interviews.**

Nearly all students thought that the first two interviews were successful. However around 40% of all students expressed less satisfaction with the first interview. Undergraduates disliked the open forum style of questioning either because they felt that not all their questions were addressed or because they believed that other students were asking irrelevant questions. It should be noted that the client and stakeholders remained for a considerable time for the first interview and until all questions were exhausted. While postgraduates tended to appreciate that the first interview provided an overview of the problem and context it was not detailed and specific enough in addressing the requirements. One postgraduate appreciated that others had thought of questions that they did not think to ask and another admitted that his team had had no idea what questions to ask. Undergraduates appeared to have a stronger preference for controlling the questions being asked compared to postgraduates. There was virtually no dissatisfaction with the second interview because students had total control of the questions being asked and they believed they had obtained sufficient understanding of the problem and requirements to begin working on finding solutions.

**1.4 Virtually all postgraduate students believed that the criteria for successful initial interviews were that they understood the problem and were able to define the project scope. Of the undergraduate students only a third cited these aims while the remainder cited a variety of other reasons such as having their questions answered, having their recommendations accepted or obtaining the requirements.**

There was a significant difference in responses between undergraduates and postgraduates to the theme of what was "success" in the initial interviews. While virtually all PGs mentioned understanding the problem and most (64%) mentioned determining problem scope as criteria for success, only some (29%) of UGs mentioned these. Similarly, 57% of PGs mentioned understanding the current environment or process while none of the undergraduates specifically mentioned this. Some (29%) of PGs mentioned the client in some way (e.g. their expectations, perceptions about solutions) while only one UG (5%) mentioned the client in this way. On the other hand 33% of undergraduates considered having all their questions answered as a criterion for success (compared with 14% of PGs) and 36% of undergraduates mentioned getting the requirements (compared with 14% of PGs). Some students (10% of undergraduates and 29% of PGs) suggested that successful interviews would be determined by whether their suggested solution was accepted by the client (and in one case actually implemented) as the criterion for success. Overall, it would appear that PGs are more explicitly interested in understanding the problem, the current situation and showed some (small) interest in the client. Undergraduates as a group were more scattered in their responses to deciding what constituted success and were somewhat more concerned with having questions answered and getting the requirements.

6.2.2.3 Question 3 Business problem and its importance

**1.5 Students varied widely in their description of the client's problems with only a few correctly identifying both of the client's key problems/goals (as later determined by the experts). Some students proposed that the implementation of a particular IT solution was the problem to be solved.**

Students tended describe the project in terms of solving a single problem or achieving a single goal however, they were differing views as to what was the problem or goal. The elimination or reduction of paper at meetings was mentioned by many postgraduates (38%) and most undergraduates (65%). Also often mentioned, in a varying ways, was a desire to improve the efficiency and effectiveness of the meeting process (27% of undergraduates and 46% of PGs). A few students mentioned both of these as problems needing to be solved (14% of undergraduates and 15% of PGs). Some postgraduate students (23%) described the problem or goal in terms of a specific IT solution, namely the need for some form of document management system. One undergraduate student described the problem more generally as a lack of automation. Other problems mentioned by UG students were that the client didn't understand user requirements, that face to face meetings were being held (as opposed to some form of online system) and change management.

Most students did describe the problem/goal from the clients' perspective although a few focussed on an IT solution. Only around 15% of students mentioned that there were two problems/goals described by clients. As well, a few students mentioned different problems or goals. If we accept that it is extremely important to have a clear understanding of the problems and goals of the project then the great majority of students provided a rather incomplete discussion of these problems and goals especially given the considerable amount of time provided for interviews.

**1.6 While students addressed the client's motivation for the project there were no particularly dominant themes.**

Postgraduates and undergraduates were similar in their response to this theme of client's motivation for the project. Overall, around one third of students in both groups did not address the issue of client motivation for the project. Four undergraduates thought that the project was of great importance to the client while one believed it was of low importance but these students did not state any particular underlying motivation. A few students (18% of undergraduates and 15% of postgraduates) mentioned conforming to the organisational goal of sustainability. Three postgraduates (23%) mentioned the improved meeting process as the motivation. Other reasons given were saving paper, saving time, money, greater efficiency and protecting the environment.

**1.7 Students gave a variety of reasons for why they believed a project to be realistic, these included that the client was genuinely interested in solving the problem, the problem posed was a common one (mostly postgraduates), while for some (only undergraduates) realism was related to perceiving that a solution could be found.**

Most undergraduates (73%) addressed this theme compared to only 46% of postgraduates. Some undergraduates (23%) thought that the project was realistic because they believed that satisfactory solutions could be found; no postgraduates mentioned this. While 32% of undergraduates thought it was realistic because they perceived that clients were genuinely interested in solving the problem only one postgraduate (8%) mentioned this. On the other hand 38% of postgraduates described the problem as realistic because they saw this problem as a common situation across other organisations while only 14% of undergraduates mentioned this. Overall postgraduates seemed less concerned about realism and of those who mentioned it they expressed it as realistic because it was a problem across many organisations. Undergraduates on the other hand interpreted realistic to mean that solutions could be found (with a couple expressing a little doubt in their skills) and appeared more concerned that the problem was of genuine interest to the clients.

**1.8 In terms of their own personal motivation, students most common motivation was that the problem was a common one or that they could see the potential for a solution to extend to other part of the organisation; post graduates most appreciated that it was a real world application.**

The great majority undergraduates (73%) and postgraduates (69%) addressed their own motivation. The most common reason given for interest in this particular project by undergraduate student (45%) was the potential application to other parts of the organisation or that it was a problem common to many other organisations. Some postgraduates (31%) mentioned that it was real world application. The difference here could be explained by the fact that many of the undergraduate students would have undertaken several months of work in the IT industry as part of their coursework and so were not so concerned with real world application but rather its importance and its broader application. Relatively few PG students have had experience in the IT industry and fewer still in an Australian context.

#### 6.2.2.4 Question 4 Control Strategies

**1.9 Regarding control strategies to determine if the project was on track the most common strategy given by both undergraduate and postgraduates was team meetings and other team interactions. However, a point of difference was that a third of post graduates (and no undergraduates) mentioned reviewing interview notes with clients and developing models as a strategy whereas a third of undergraduates (and almost no post graduates) mentioned meetings with their supervisor.**

The question was aimed at determining how students ensured that the right problem was being solved. Overall, for both UGs and PGs relatively few mentioned client feedback as a control strategy for determining whether they understood the problem, scope and requirements with only 23% of UGs mentioning this and 18% of PGs. One marked difference between the groups was that 29% of PG students mentioned strategies related to recording and reviewing information from interviews and developing models as a control strategy whereas none of the UGs students mentioned this. Another difference was weekly meetings with their supervisor with 36% of UGs mentioning this but only 6% of PGs. Regular (at least weekly) team meetings was the most often mentioned strategy (UGs 45% and PGs 56%). Reviewing each other's work was mentioned by 18% of UGs and 35% of PGs. If all strategies mentioned by students related to assisting in developing internal team agreement and consistency (e.g. weekly team meetings, reviewing each other's work, minutes and action plans, team document repository, good communication between team members) are combined then another marked difference is observed with 54% of UGs mentioning one or more of these strategies compared to 82% of PGs.

Overall, we can characterise the results by saying that relatively few students mentioned getting client feedback as a strategy for determining if they understood the problem, scope and requirements. Even fewer mentioned strategies related to recording and reviewing information from interviews or developing models. Most students (particularly PG students) showed concern for internal agreement and consistency amongst their team members. UG students appeared considerably more reliant on their supervisor meetings than PG students.

6.2.2.5 Question 5 Personality type and personal relevance

**1.10 When students were asked to undertake a personality test and discuss the results, three quarters of the post graduate and undergraduate students thought that it was consistent with their own view of themselves. Only one third of undergraduate students found the results helpful with around a quarter expressing a negative reaction whereas two thirds of postgraduates found it helpful.**

While virtually all students did the Myer Briggs personality test only about three quarters of the students revealed their results in their journal. Three quarters believed that the test results were consistent with their own view of their personality. However, only 36% of the undergraduates said that they found it useful describing the experience as interesting, informative and helpful. A quarter of the undergraduates were sceptical of the results citing doubts about its reliability or repeatability. 88% of postgraduates revealed their personality type and nearly three quarters believed it was consistent with their own view of their personality and nearly the same finding it a positive experience. There were no negative responses from postgraduates with around 60% stating that they believed it helped them better understand their strengths and weaknesses and a quarter suggesting it would be helpful in terms of team dynamics.

6.2.2.6 Question 6 Personality type comparison with team members

**1.11 Students discussion of different personality types (as determined using the Myer Briggs test) within the team was in the great majority of cases was vague, superficial or one dimensional. Having different personality types in a team was most often seen as a problem due to the potential for conflict although some (one in eight) thought it could be a positive influence.**

Many responses were vague and ill informed. On reflection, most students' perspective was that having differences across the various personality dimensions was a problem that needed "fixing".

The application of the Myer Briggs test seems to have been useful for self-understanding and it made students aware of how other students might differ from them. When it came to team dynamics there were two different views. The first was to suggest that the differences in personality types could lead to disagreement or exclusion and this was a problem that needed to be dealt with. 82% of PGs had this view. The second view was that disagreement and conflict was potentially positive because it could provide a more holistic approach which might enhance project outcomes. 12% of PGs

demonstrated this view. On the whole students attempts at a more detailed analysis and discussion were quite poor.
These findings suggested some other approach to understanding team dynamics could prove more useful.

6.2.2.7 Question 7 Team Agreement and management

**1.12 On team agreement on standards and goals, most postgraduates (two thirds) believed that team discussions would lead to agreement on goals and standards with around a third stating that they had explicit agreements in place. Only a quarter of undergraduates stated they had explicit agreements in place and a third believed they had implicit agreements. Undergraduates suggested a variety of means for agreement such as team meetings, emails and a common website but no particularly dominant theme merged. While expressing hopes, no students mentioned any explicit process to ensure fair distribution of work amongst team members.**

On the question of team agreement on standards and goals, students divided into roughly three groups with about 30% stating that they had explicit agreements in place, 30% stating they had implicit agreements (or so they believed) and 40% not indicating one or the other. Post graduates were more likely to have explicit agreements on goals and standards (one third) compared to undergraduates (one quarter). On the other hand more undergraduates believed they had implicit agreements (one third) compared to postgraduates ((one quarter). More postgraduates (two thirds) suggested that discussion in team meetings would lead to shared goals and standards compared to undergraduates (one third). A greater proportion of undergraduates (one third) compared to postgraduates (one quarter) thought that peer review of their work among team members would maintain quality and standards of work. Other means mentioned of developing agreement were extensive use of email or a shared website. The fair sharing of work was mentioned by only 30% students overall but of these none described any explicit process as to how they would achieve this although there was some who suggested that the team (or team leader) would aim to share work fairly.

6.2.2.8 Question 8 Understanding the unit requirements

**1.13 The great majority of students believed they understood the work required and standards to be achieved for their final reports. Access to reports from**

**previous projects alerted them to unforeseen issues or to rethink the depth of research or analysis required.**

The great majority of students (86% of UGs and 76% of PGs) believed that they understood the work that was required, standards to be achieved and had gained some guidance regarding the possible structure of their report. The discussion within the responses suggested that reviewing reports had alerted them about issues that they had hitherto neglected or to rethink the depth of research and analysis that was expected. A few students (14% UGs and 24% of PGs) either did not respond to this question; had not looked at the reports or appeared to misunderstand the question. The results from Journal 3 will suggest that students were somewhat overconfident in their beliefs.

6.2.2.9 Question 9 Learning form team mates

**1.14 The great majority of students believed they had learned something positive from their team mates. This largely concerned team work with students mentioning the need for constant communication, flexibility and that cooperation builds goodwill, enthusiasm and encourages greater effort. A very significant number believed they had learned or improved on specific skills or ways of doing things from particular individuals.**

The great majority of students (77% UGs and 88% of PGs) stated that they had learned something from working with their team members. In some cases this learning was about dealing with people in a team environment (64% of UG and 53% of PGs). On the positive side, some of the things learned were the importance of constant communication, flexibility and adaptability in dealing with others, how cooperation builds goodwill and that enthusiasm encourages greater effort. On the negative side 5% of students had learned that some people are unreliable or have poor attitudes. 36% of UGs and 53% of PGs mentioned learning something from a single individual such as how to more effectively format documents, using a document sharing site more effectively for team collaboration, planning ahead so that things were not left to the last minute, observing and learning from another team member's confidence in expressing ideas. Finally, 18% of UGs thought they had learned nothing from fellow students while only 6% of PGs stated this.

6.2.2.10 Questions 10 and 11 Supervisor meetings and supervisor support

**1.15 Students overwhelmingly stated that they found meetings with supervisors useful. They appreciated having feedback, having supervisors ask them probing**

**questions, giving guidance, helping them to focus or alternatively to see their project in a wider context. Having the supervisor keeping the team on track was often mentioned and when teams were already on track it gave them greater confidence when this was acknowledged.**

Nearly all students (86% of UGs and 100% of PGs) responded that they found the supervisor meetings useful. Of the remaining 14% of UGs one (5%) had not attended any meetings and the other two (8%) discussed an issue of a supervisor needing to intervene in a change of the team leader. The most dominant theme by UGs (82%) and PGs (88%) was that they appreciated their supervisor's feedback. Responses from students mentioned being able to "*bounce ideas off him*", the supervisor asking probing questions, providing guidance on areas they should be investigating, what to focus on, helping them clarify the problem or scope, looking at the "big picture" as well as details and thinking more broadly on the solution options. Supervisor meetings also helped to keep teams "on track" (41% UGs and 24% PGs). "On track" was a term used by many students and which I am interpreting to mean working on the right tasks in an appropriate manner and/or at an appropriate pace to finish the project successfully. Even teams that were already "on track" appreciated their supervisor's acknowledgement of this and this appeared to give them confidence and motivation. A couple of comments by PG students are worth mentioning. One was that the supervisor meetings provided an occasion when team member contributions were acknowledged and encouragement given and another that these meetings improved the student's ability to participate and to share his ideas.

## 6.3 Journal 2

### 6.3.1 Introduction

This journal was required to be submitted approximately two thirds of the way through the project i.e. at the end of eighth week of the 12 week project. By that stage teams should have established a reasonably detailed set of requirements and researching candidate solutions. Further interviews had been conducted (most one-on-one) and requirements prioritized by the client and other stakeholders. Some teams may have begun thinking about their final report to the client even if they had not actually started working on it. Weekly meetings of the team with their supervisor continued and contact with the client and other stakeholders also continued but with fewer meetings and of shorter duration. One notable meeting was a briefing held with a senior representative of the group that provided information technology services for the organisation. The representative discussed the role of their group, the software infrastructure and support provided and indicated that, as part of a larger corporate initiative, they also were considering software to support meetings which they expected to have in place some 18 months in the future. This demoralized a few students who assumed without question that this would occur as stated and thought that their work would therefore be a waste of time. After the briefing supervisors indicated that it was possible that this software might not be delivered at all, or if delivered that it might be delivered much later in the future than suggested or even if delivered in time as proposed it would not necessarily meet the specific requirements of their particular client so, in fact their work would not be wasted. As supervisors had suggested, at the time of writing the initiative appears to have disappeared or is dormant.

The detailed analysis of the journal is provided in Appendix C - Journal 2 Analysis.

## 6.3.2 Results for Journal 2

### 6.3.2.1 Questions 1 & 2 Change in understanding of problem or scope

The responses to these sets of questions were combined since the responses appeared to overlap or partially redundant.

**2.1 The great majority of all students (75%) stated that subsequent client meetings refined the details but not their general understanding of the problem, scope and requirements. However a few postgraduates (15%) realised with these further meetings that they had misunderstood the problem and had prematurely decided on a solution. Some undergraduates (30%) wanted client further meetings but no post graduates.**

**2.2 Some (30% and mostly undergraduates) were critical of the client for not being better prepared with his description of the problem, scope and requirements.**

**2.3 A few students noted or were surprised that the client's understanding and needs also evolved as the project progressed which then required them to modify their work accordingly.**

75% of UGs and 92% of PGs responded that further meetings with the client and other stakeholders had clarified their overall understanding of the project and/or helped them to further develop the requirements. For most students the broad scope was maintained but the granularity of detail improved. Interestingly, 15% of PGs mentioned that they had initially misunderstood the requirements and subsequent interviews corrected this; these students prematurely assumed a type of solution (e.g. a document management system) rather than ensuring that they had understood the client's problem description (e.g. a perceived need to improve the management, administration and productivity of meetings). In contrast, 15% of UGs stated that the further interviews made no significant difference to their understanding or requirements. Another point of contrast between UGs and PGs was that no PGs expressed a desire for more meeting time with clients or other stakeholders, 30% of UGs expressed this desire for more time although one of these students also admitted that his workplace experience was that clients were "*rarely*" available for extended meeting time.

The area in which both UG and PG students mentioned difficulty was in relation to determining the problem scope. For example "*the team have gone a bit side track in terms on the requirements of the project. This is a big issue as we might deliver a wrong solution to the client as what we propose are not what the client have requested". And following on from this, "we came up with features which were out of scope.*" Another student found that their scope had focussed too narrowly and then found that "*we had to look a bit more deep[ly] into all the other concerns*".

With regard to interviews one PG student realised that interviews required more planning and forethought than they had anticipated, "*we didn't explore how to get most of these meetings" while another seemed surprised how much information could be provided in an interview … the conversation[s] were quite informative. It seems that notes taking are quite important. To some questions, I just could not put all the answers on paper.* "

UGs (30%) expressed more critical comments about their client than PGs (8%). A common theme was to shift the burden of defining the problem, scope and requirements onto the client. Some examples include the following: "*the requirements from the client should have been documented from the beginning to ensure groups are on the right track" and "If the client had been more specific (& less general; in terms of requirements) from the initial interview – then the problem understanding might have been made clearer earlier*". One student suggested that the clients would be inflexible in their attitudes, "*the clients seem to be looking for a technology fix without the need to change their behaviour and ideas*".

For some students it was while researching potential solutions that a difference or change in perception of the problem or scope became apparent. This might be because of misunderstanding by the team or changing understanding on the client's part. For example, "*The meeting with Business Analysts also helped us to think in the way what exactly they are expecting the system from us. It is been productive we have changed the way we were working by widening the search of solutions*". On the other hand a perceptive comment by one PG student was the following, "*it is evident the client now has a better grasp on their concept then when then project was first introduced. Due to my lack of experience I am unsure to state this is common or not in projects. However, I assume that the client understanding of the knowledge area would deepen over the course of any project*". Another student mentioned this evolution as a surprise, "*To our surprise the client's requirements had changed a bit and this meant that we had to redo a lot of our work. The constant meeting with the client was very important as we saw a different side of the project and made the team realize that we had to revisit the client after achieving the major milestones.*"

6.3.2.2 Question.3 Control strategies for finding solutions

**2.4 In terms of strategies to find the best solutions or recommendations, the most cited strategy was to map potential recommendations or solutions against the client's (prioritized) requirements. Some post graduates (15%) suggested mapping interview notes against requirements.**

By far the most cited strategy by 50% of UG students and 62% of PGs was finding and short listing solutions or recommendations by mapping against the client's set of requirements as their control strategy. 15% of PGs (no UGs) mentioned mapping interview notes to requirements. Students also mentioned other strategies one of which involved peer review. As one student put it, "*Peer reviewing all research is the main way this is done within my group. Since all researched information regarding solutions is reviewed by at least one other person, we know the work is of substantial quality. This is similar to the principle of "paired programming" applied in computer science*". Supervisor meetings were mentioned by 20% of UGs and 18% of PGs.

The role of the supervisor emerged in the answers to this set of questions. There can be a fine line between a supervisor supporting the team as opposed to controlling the team. For example this response, "*One of the main controls for the group to stay on track is the weekly progress meetings with [expert P]. Throughout the week, we were able to gain feedback on our progress, ideas and completed tasks.*" This suggested a supportive role. However, one PG student wrote, "*We used our supervisor as our* *control administrator; we shown him our work weekly and asked him to validate … I personally feel that we didn't get enough control from the supervisor.*" This suggested that the student thought the project was the responsibility of the supervisor and not the team.

6.3.2.3 Question 4 Meeting objectives, managing workload and standards

**2.5 In terms of means of achieving project management objectives such as meeting deadlines and achieving targets, the items most mentioned by undergraduates in terms of assisting them achieve their objectives were team meetings with minutes and action items (50%), adhering to the project plan (30%), peer review of work (20%) and supervisor meetings (20%). Postgraduates most mentioned items were peer reviewing (46%), adhering to the project plan (38%), supervisor meetings (18%) and team meeting (15%). 30% of undergraduates suggested that their satisfactory progress to date was evidence of adequate control strategies.**

**2.6 Half of the undergraduate students believed that work was shared equally among team members compared to many of postgraduates but there was no evidence of any processes or data provided that would support this belief.**

50% of UGs and 15% of PGs mentioned their team meetings, minutes and/or action plans. 38% of UGs and 23% of PGs mentioned adhering to a project plan as their control strategy. 30% of undergraduates stated that they had adequate control strategies but with little or no elaboration. Another strategy mentioned to maintain quality or standards mentioned by 20% of UGs and 46% of PGs was peer review to ensure that quality was maintained.

Some students suggested that their progress was satisfactory hence their management and control strategies must be satisfactory, for example, "*Our management and control strategies are working very well, as evidenced by our outstanding results for our tasks to date.*"

With regard to the sharing of work 50% of undergraduate students responded that work was equally shared among the team members, however this division of work appeared to be on an ad hoc basis based on perception and trust rather than on evidence. Some other control strategies mentioned by undergraduate students having a good means of communication among the members outside meetings (15%). 38% of postgraduates mentioned that work was shared equally but on the whole postgraduates seemed less concerned about this issue. Post graduates placed more emphasis on the peer review process (46%). Other strategies were similar to undergraduates e.g. meetings with meeting minutes and action plans (23%), and having a good means of communication amongst the members outside meetings (15%).

6.3.2.4 Question 5 Team interaction

**2.7 Students overwhelmingly thought that their team was working well. However, most responses did not elaborate or try to analyse in which ways in which the team was working well. A few students did suggest that the differences in perceived personality types in their team was a positive influence through providing different viewpoints and approaches or that understanding that students had different personality types promoted greater tolerance among the team members.**

Overall, the overwhelming majority of students (100% postgraduates and 80% undergraduates) did make reasonable attempts at trying to describe the team dynamics but not many tried to do it by using the Myer Briggs personality types (or any other approach) and those that did tended to focus on the introvert/extravert dimension to the exclusion of other dimensions. The underlying criteria students appeared to use to define success was that the team members got on in a reasonably friendly manner and that they perceived that project progress was being made.

Some students (both undergraduates and postgraduates) did suggest that understanding personality types promoted greater tolerance of differences and appreciation that it could be a positive influence in terms of providing different perspectives and types of contribution. This is in contrast to the responses in the previous journal (1.11) were differences in personality type in a team were regarded as negative. Negative comments about team dynamics by students were few and scattered amongst the teams except in one or two dysfunctional teams as might be expected.

On the whole the relatively shallow nature of the responses regarding team dynamics reinforces the idea that other approaches more specifically designed toward understanding small group dynamics and projects could be more productive.

6.3.2.5 Question 6 Personal contribution to team

**2.8 In describing their own contribution to their team post graduates' most mentioned areas of contribution were in attention to detail (46%), leadership (38%, mostly mentioned by team leaders), organisational skills (31%), team building and interpersonal skills (30%) and management and planning (23%). For undergraduates the most mentioned areas were in leadership (30%), team building**

**and interpersonal skills (30%), organisational skills (25%), attention to detail (25%), creative thinking (23%) and communication skills (23%). Post graduates thought leadership was the area they most wanted to improve (23%) while for undergraduates it was assertiveness (15%).**

Few strong themes emerged from this question. 46% of PGs suggested that attention to detail as their contribution while only 25% of UGs mentioned this theme. 38% of PGs mentioned leadership compared to 30% of UGs and in the great majority of cases these were the appointed team leaders making this comment. 30% of UG and 23% of PGs mentioned team building and interpersonal skills; this is characterised by comments such as the student doing "*a lot of thinking before doing the task clarifying among members and getting everyone's approval before going ahead*" or that "*I'm more concerned that if we are on the right track and if we are working towards the same goal*" amongst others. 31% of PGs and 25% of UGs mentioned their organisational skills as a contribution. Other contributions mentioned by both UGs and PGs were communication skills (writing, speaking), management and planning, and creative thinking. Both PGs and UGs were reticent in suggesting areas for improvement but when they did UGs wanted to show more assertiveness (15%) and leadership (10%) while PGs mentioned leadership (23%).

6.3.2.6 Question 7 Learning from tem members

**2.9 Since their previous journal submission postgraduates mentioned that they had learned most about issues related to management and leadership (46%), effective communication with a focus on overcoming shyness and being able to express their ideas clearly (38%), improving personal productivity (31%) and critical thinking (23%). Undergraduates mentioned a wider range of topics but most mentioned was an appreciation of the importance of frequent and effective communication among team members (35%), appreciation of the different perspectives provided by others (20%), improving personal productivity (20%) and the importance of being motivated (20%).**

Overall, PG students had fewer but stronger themes compared to UGs on team work related issues. PGs demonstrated more concern compared to UGs with working as a team rather than individuals, about quality of leadership and that team members were cooperating toward achieving shared goals. On the other hand, UGs expressed more concern with trying to ensure that communication took place, how it was achieved and that it was positive in nature rather than negative.

The strongest theme by PGs was team management and leadership (46%) while only 20% of UGs mentioned this theme. PGs described the value of defined roles for members, being organised and focussed while others described the need for flexibility. On the other hand UGs described how they were learning how to gain cooperation from team members or were simply impressed by the leadership skills shown by their team leader.

38% of PGs and 35% of UGs mentioned effective communication but the emphases were somewhat different. PGs expressed more concern with overcoming shyness or fear in expressing ideas and then to do so clearly while UGs were more concerned with communication to keep each other informed, listening to the ideas of others and communicating in a manner to engage others and not alienating them. Both PGs (15%) and UGs (25%) appreciated the different perspectives and approach that other team members provided.

Themes mentioned by PGs that were not mentioned by UGs were supporting team members (15%) and working towards team goals (15%).

In terms of personal development themes, undergraduate students mentioned learning to improve their personal productivity (20%) by observing how others were better organised and finished work ahead of time. Similarly 31% of postgraduate described getting ideas about improving their own personal productivity through observing other students' techniques for researching, reading and task management. Differences between postgraduates and undergraduates responses were that postgraduates mentioned critical thinking issues (23%) related to problem solving techniques and just thinking through things before acting whereas undergraduates mentioned motivation (10%) and a positive attitude (20%) with some impressed by the positive motivation toward work shown by some team members and disappointed by the lack of motivation in others.

#### 6.3.2.7 Question 8 & 9 Outcomes from supervisor meetings

**2.10 Regarding the value of meetings between the team and their supervisor most undergraduates and the great majority of postgraduates most appreciated the feedback on their work. The majority of undergraduates and many postgraduates appreciated feedback on whether they were on the right track, that the supervisor helped them to clarify and develop ideas (50% and 65% respectively), facilitated**

**team dynamics, organisation or management (20% and 24%) and provided advice on personal development and productivity (20% and 24%).**

Both postgraduates and undergraduates (88% and 65% respectively) appreciated the role of the supervisor in keeping the team on track toward a satisfactory completion of the project by either confirming that their progress appeared satisfactory, providing guidance on how to get it back on track or simply urging them not to slacken the pace of work. Students appreciated the feedback on the quality of many aspects of their project whether it work that they were producing e.g. presentations, reports (65% undergraduates, 41% postgraduates), meeting minutes, action plans, project schedules etc. or the way in which the team or a particular individual operated e.g. leadership, management, workload, team interaction, productivity and so on. These were issues which many students felt unsure about regarding dealing with a real world client and problem and supervisors helped in these matters.

Supervisors helped teams to better understand and clarify their ideas (undergraduates 50%, postgraduates 65%). Examples mentioned by students related to understanding the problem, the contextual issues, requirements specification, assessing solutions, asking probing questions which highlighted areas where further work was required. Supervisor meetings were also a regular time that encouraged teams to pause and reflect more deeply about their project and what they were doing.

Supervisors also facilitated the team dynamics, organisation or management (undergraduates 20%, postgraduates 24%) such as more efficient allocation and division of work, more effective leadership style, better communication strategies, encouraging greater contribution from all team members etc. Guidance on personal development issues such as overcoming shyness, better personal organisation, accepting and learning from criticism, personal attitudes and so on were also mentioned (undergraduates 20%, 24% postgraduates).

## 6.4 Journal 3

### 6.4.1 Introduction

This journal was completed at the end of the project. This last journal included the latter stages of research and making decisions about recommendations, preparing for interviews and writing the final report for the client. It also asked students for their views about the project and project learning environment that was provided. Detailed results can be found in Appendix C Journal 3 Analysis.

## 6.4.2 Results for Journal 3

### 6.4.2.1 Question 1 Aims for final presentation

**3.1 Most undergraduates thought their final presentation (to academic staff, clients and other interested parties) went well with many concentrating on doing their own part successfully but many also thought that the presentation could have been better with some criticizing themselves and some criticizing other team members. Many postgraduates thought their presentation went well and expressed no criticism of themselves or others.**

**3.2 More undergraduates thought they had not rehearsed enough for their presentation compared to those thought they did. Postgraduates where equally divided.**

**3.3 Undergraduates' and postgraduates' aims for the final presentation were similar with many or most (respectively) wanting to demonstrate their methodology and build credibility, present their solutions, focus on the client and some wanting to target it well to the audience. Some undergraduates mentioned the idea that they were promoting or selling their solution.**

Most UGs thought that their final presentation went well (55%) compared to only 36% of PGs. Specific reasons why they believed it had gone well was the interest shown by their client at question time or that the presentation went smoothly from their perspective. Those UGs that stated that their team's overall presentation could have been better (45%) were more inclined to criticise the performance of other team members (20%) and not their own performance. 40% of UG students mentioned concentrating on successfully doing their part and were inclined to suggest that their contribution could have been better (20%). In contrast, no PG students mentioned their own particular performance or criticised the performance of the other team members. With regard to rehearsing, the students' perceived performance did not correlate with their stated effort spent rehearsing. Although overall UGs were positive in their self-evaluation of the presentation, 55% of UGs thought that their presentation was under rehearsed compared to 20% who thought it was well rehearsed. On the other hand, although PGs were less positive about their presentation, 50% of post graduate students thought that their presentation was well rehearsed. A possible interpretation is that PGs were more critical in their self-evaluation of the presentation. One UG student for example commented on a couple of technical mishaps and problems with timing in the presentation and suggested that more rehearsal might have helped but still thought the presentation had gone well.

6.4.2.2 Question 2 Final report issues

**3.4 Most undergraduates found writing the report required significant effort; with many of these believing they understood what was required and many stating that they found it challenging. No undergraduates mentioned looking at sample reports that were provided. Some postgraduates stated they found writing the report required significant effort and were generally more positive in their comments about the process. A few postgraduates (no undergraduates) mentioned looking at the sample reports provided.**

**3.5 Complaints by some undergraduates on the report writing process were about lack of contribution by team members even though all undergraduates claimed to have made a significant contribution. Some undergraduates also stated that they had difficulty coordinating others and that there were problems with tardy contributions or work of poor standard.**

100% of UG students and 82% of PGs stated or implied that they had made a significant contribution to their team report. 50% of UGs and 76% of PGs stated that they understood what was required in their report. A few PGs (but no UGs) mentioned that looking at previous reports which were provided was a useful guide.

60% of UGs stated that the task of reviewing and consolidating the report required significant effort compared to only 35% of PGs. While 25% of UGs expressed frustration with other team members being tardy with their contributions or providing work of poor standard, 30% also stated that other team members had made a significant contribution to their final report.

PGs tended to be more positive and less personal in their discussion regarding the production of their report. While 35% found the process of reviewing and consolidating the work challenging and 24% finding that coordinating team members something of a problem, 29% stated that they thought the process went smoothly. Based on observation and supported by these student responses, an interpretation is that within teams there tended to be one or more members who had the major responsibility for report production and dealt with the real problems of coordinating efforts, reviewing and consolidating the report while others simply contributed their sections. For the latter set of students who only provided limited input into the report the development process might well appear fairly straightforward to them.

In comparing the UG and PG groups, UGs either seemed to have more difficulties working with some team members (e.g. team members being unreliable or tardy) or quality of contributions (e.g. team members' writing skills). PGs seemed less personal in criticisms and generally described problems in the process. Some speculations on this difference are that it might be simply a random result due to the small sample sizes; or that PGs are, on average, somewhat more responsible as team members; or PGs are less inclined to complain; or PGs may be a bit more forgiving of other team members' weaknesses.

6.4.2.3 Questions 3 and 4 Supervisor support

**3.6 The great majority of undergraduates and postgraduates expressed their appreciation of the feedback from supervisors in the preparation of their final presentation. They suggested that supervisors indicated the need for evidence and rationale, description of research undertaken, simplicity and clarity, omitting material on internal team functioning and issues and presentation style.**

**3.7 Half of undergraduates and most postgraduates (many whom were international students) appreciated feedback provided by supervisors with writing their final report.**

**3.8 Some undergraduates mentioned their supervisor had helped clarify ideas while some postgraduates mentioned aspects related finding solutions.**

**3.9 Some students stated that their supervisor was still involved in helping to keep their project on track in the latter stages of the project.**

**3.10 Many undergraduates and postgraduates suggested that they would not need as much help with projects in the future.**

**Overall:**

The strongest theme mentioned by 70% of UG students and 76% of PGs was that supervisors provided advice and feedback on the final presentation to the client. In terms of the presentation content, supervisors suggested that relevant content included examples such as the research undertaken to find candidate solutions, the means by which recommended solutions were determined etc. Not considered relevant was content such internal team functioning, dispute resolution etc. Other advice was provided in terms of presentation style, ordering of the presentation of ideas and the need to provide evidence and rationale.

There were a variety of comments of a general nature about supervisors altering a students' ways of thinking. Some comments related to providing different perspectives e.g. "*Supervisor assisted me in terms of presenting solutions to the client in clearer and simpler way. He helped me to know and understand the client is non IT person*" or "*According to me the most important outcome was to see how I refined my thoughts in terms of understanding the project [to the] supervisor point of view.*"

The next strongest theme at 50% and 65% for PGs was supervisors providing advice and feedback on the final report but there was little detail about the advice provided. The higher percentage for PGs compared to UGs with regard to report writing might be explained by the fact that PGs tended to be international students for whom English was often not their native language and also less confidence with business culture.

30% of UGs mentioned that their supervisor helped in discussing and clarifying ideas brought by team members whereas this was not a significant theme amongst PGs. Amongst UGs, one student stated *"[Our supervisor] has been a valuable resource in mining and developing our numerous business ideas for the client.*" Another student mentioned that "*more of our discussions took place about 'outside the box' type ideas and this is where our discussions would lead off. Our team as such have a lot of ideas and it was really good talking to our Supervisor about them.*" Finally, "*each member typically has their own view and during the weekly meeting, the supervisor helps clarify such thoughts.*"

It is clear that keeping the project on track was still an issue for some students even in the last stages of their project (25% of UG and 12% of PG). As one student mentioned, "*the tracking of our progress and seeing where we stood with our timeline. It was important to know that we were on the right path.*"

In terms of finding the finding appropriate solutions, 25% of PGs mentioned discussion with their supervisor.

35% of UGs and 41% of PGs stated they would not need as much help in the future which presumably could be interpreted to mean that they believed had learned skills that they could re-use in the future.

A weak theme (10%) for UGs worth mentioning which did not appear at all for PGs was students complaining that they did not know exactly what was required e.g. "*I felt like with this subject in general there was a lack of clear outlines and an indication of* *what exactly was required"* and similarly another student who complained about *"the absence of marking guides*".

6.4.2.4 Question 5 Principles demonstrated by supervisors

**3.11 Students suggested that the key ideas supervisors espoused were effective project management, teamwork (particularly communication and being supportive), communicating and working with the client and critical thinking. Undergraduates also mentioned maintaining a positive attitude.**

For all students the strongest themes espoused by supervisors related to project management (undergraduates 35%, postgraduates 24%), teamwork (undergraduates 30%, postgraduates 18%) and working with the client (undergraduates 35%, postgraduates 24%). A common theme within teamwork and working with the client was communication (undergraduates 30%, postgraduates 24%). In regards to project management students mentioned planning ahead, the assignment of roles to members and clear, transparent and explicitly recorded allocation of tasks with timelines as key points made by supervisors. The students who mentioned project management were also likely to discuss the importance of effective team communication as well. One student described communication as the "*cornerstone of a successful project*" while another mentioned it as important to resolving internal issues within the team. Other points mentioned were that communications needed to be frequent and the importance of being able to see things from the client's perspective.

Critical thinking skills were mentioned, although not strongly, by both undergraduates (20%) and postgraduates (18%). Maintaining a positive attitude was mentioned by 20% of undergrads but not by postgraduate students.

Other weaker themes mentioned were the development of presentation skills, understanding the problem and scope management, to think holistically and creatively, and problem solving skills.

6.4.2.5 Question 6 Application of previous learning

This was a question related to particular units taught at this university and related to the specific project that students worked on. It did not appear to be of significant enough value to include these results in this chapter. However, the results are provided in the Appendix C.

6.4.2.6 Question 7 Understanding of the project

**3.12 Asking students when they believed they understood what they were trying to achieve with regard to their project and how to get there resulted in a variety of answers. Many undergraduates expressed confidence in their understanding early in the project compared to only a few postgraduates. Many undergraduates and postgraduates stated they understood around midway through the project and a few postgraduates only toward the end of the project.**

The great range of responses suggests differing interpretations of the term “understanding” and perhaps each student’s confidence in their own ability. Some may have interpreted this to mean that they understood the broad features enough to start the project while others at the other extreme believed they didn’t understand it fully until the time they had completed the project and were able to reflect back on it from start to finish. Students could also be expressing their self-confidence at a certain point in time which may not have aligned with the supervisor’s assessment of the student’s understanding of the problem and task. Be that as it may, overall UGs expressed more confidence in their understanding of the project compared to PGs.

35% of UGs thought they understood the project compared to 18% of PGs in the very early stages of the project i.e. after one or two client interviews. By midway through the project when several interviews had been completed and some initial research would have been accomplished 40% of UGs compared to 41% of PGs stated that they understood the project. In the latter stages of the project when teams would have been refining solutions and/or preparing for presentations 18% of PGs (and no UGs) stated they understood the project.

UGs stated that their understanding grew with further stakeholder interviews (30%) or that the details became clearer (20%). 24% of PGs stated that their understanding grew with further stakeholder interviews. Both UGs (24%) and PGs (20%) found that some form of prior knowledge help them to understand what was required.

Overall, one possible interpretation of this is that UGs were simply more confident earlier on in the project when the scope and objectives were still somewhat vague, while PGs became more confident later in the project when achieving the project objectives were more clearly in sight.

#### 6.4.2.7 Question 8 Knowledge and skills acquired

**3.13 When asked what they had learned from their work on the project that was new or extended their knowledge or skills there were a wide variety of responses. Some undergraduates and postgraduates mentioned team work, team management or team building. For postgraduates many expressed appreciation of application of prior (academic) learning. Other common themes mentioned by a few or some students were being able to deal directly with the client and stakeholders; working in a realistic environment and with a practical problem, working with uncertainty and knowledge developed about the particular software application involved in the project.**

There was a wide range of answers for this set of questions with no particular theme that stood out well above the rest. Both UGs (25%) and PGs (24%) mentioned that they had learned something significant about team work or team management. One student discussed the communications environment, "*Something new I learnt in the project was how to work collaboratively. Using Google docs and a flexible team working formation, we were able to effectively work, review and critique others parts of the report/research without having to meet up every single time we needed to discuss something. I also learnt communication skills, as some of our team members required different types of communication to suit their personality types.*" Another student mentioned the importance of strong social bonds between team members, "*Team building was excellent in this project … it is of paramount importance to build strong relationships with team members and to understand their individual goals and objectives as to enable alignment between both parties.*"

For PG's application of prior learning (41%) was easily the most dominant theme. As one student described it, "*Real time experience of doing a project is always useful in understanding the theoretical concepts studied earlier. This project gave us a chance of implementing and analysing all the concepts learnt earlier and provide a wide understanding of the concepts and also the project.*" Given that some of the undergraduate students had already had some industry experience it was not surprising that more PGs had appreciated a realistic project in which they could apply their knowledge and skills.

Both UGs (15%) and PGs (24%) appreciated dealing directly with the client and other stakeholders and also working in a more realistic and practical situation (UGs 15% and PGs 24%).

One area of difference between UGs and PGs was that UGs (15%) mentioned that there was uncertainty as to what to do and how to do it which was not a theme amongst the PG students.

6.4.2.8 Question 9 Advise to new project students

**3.14 With respect to the advice this group of students would give to new students starting on projects or that they would apply in a new project the dominant theme by the most students was to try to understand the problem, issues and requirements as early as possible. Many students mentioned the client in this context. The importance of good team management and communication was also a strong theme expressed by many students with undergraduates placing greater emphasis on communication while postgraduates were more concerned with management. Some undergraduates urged new students to make sure they had good team members.**

The issues that most undergraduates made (55%) as did most postgraduates (60%) discussed were to ensure that you understood the problem, issues and requirements as early as possible. For example "*persist in finding out the necessary information from clients, especially when they do not reveal the information that is necessary for you to complete the project. I would also advise students to thoroughly research the questions they plan to ask their clients in order to get all the information required so that they can provide a thoroughly researched solution.*" Another, "*the main advice that I would offer would be to ensure that the requirements are clearly defined and the scope is accurate.*" Another, "*Define the requirements as early as possible. Gather as much information as you can… Progress can be slowed if your group is still unclear on certain aspects of the project half way through a semester – so do the homework & don't be afraid to ask questions.*" Finally, "*make sure that your group understands what is required first prior to beginning the research into the solution. This is a key step that sometimes can go under the radar and cause you to lose track of the bigger picture.*"

An interesting area of difference between UGs and PGs was with the issue of project management and team communication. While similar proportions of UGs (45%) and PGs (47%) mentioned this issue, the UGs focussed on the importance of good communication and only tended to mention management and leadership when there had been some problem within the team. On the other hand while PGs mentioned the importance of good team communication they were even more concerned with project planning and project methodology which UGs did not mention.

Students demonstrated an awareness of the client which was mentioned by significant numbers of PGs (40%) and UGs (35%). Responses were largely centred on the need to understand the problem, scope and requirements.

Another interesting difference between UGs and PGs was in team selection. A reasonable proportion of UGs (25%) mentioned choosing your team members wisely as poor team members would drag the rest of the team down as this student mentioned, "*choose your team mates carefully, as they will be the ones who will either help you achieve your aims or bring you down regardless.*" This was barely mentioned by PGs (7%).

PGs were broader ranging in their themes and mentioned being creative and practical with recommendations, the value of practical application of knowledge and skills and importance of commitment to the project.

6.4.2.9 Question 10 Issues regarding different personality types

**3.15 With regard to personality and team dynamics the great majority of students got on reasonably well with their team members. When there was an absence of team conflict or other obvious team related problems, it appears that there was little concern with team dynamics. Other than a few mentioning introverts and extraverts students did not discuss any of the other Myer Briggs personality dimensions.**

This analysis applies to both UGs and PGs equally. The great majority of students believed that their team got on reasonably well (with one or two exceptions). In the absence of conflict most students took the view that there was no need or purpose in trying to understand the team dynamics. It could be that the questions as framed (highlighting problems) may have suggested the viewpoint that if there was no problem then looking at personality types and their interaction was unnecessary. The analysis of interactions by students was generally intuitive in nature and there was little or no attempt to use Myer Briggs as means of understanding how or why their team operated the way it did.

Since this analysis, the material on Myer Briggs has been kept but in a reduced form as a means of self-analysis since this was appreciated by some students. What is now also presented to students is material directly related to team dynamics (specifically Belbin team roles) which discusses the various roles that team members play in teams. Anecdotally, students suggest that this easier to understand and interpret with regard to small team dynamics.

6.4.2.10 Question 11 Value of the learning environment

**3.16 Asked about their personal and professional development as a result of the total environment that was created during the project, students gave a wide variety of answers. The great majority of postgraduates gave positive comments and none giving negative comments whereas almost half the undergraduate students gave positive comments and few giving negative comments. Positive comments related to enjoying the experience, being a good or excellent learning experience, finding it rewarding and satisfying, providing a professional environment, finding it a highly effective and beneficial to personal and professional development and friendly. Negative comments mentioned were about lack of structure, lack of detailed marking criteria for assessments and having group interviews.**

Given the general nature of the set of questions the responses were quite varied and not easy to classify into sub-themes.

UGs were generally positive in their overall evaluations with 45% giving positive comments, only 10% giving a negative comment and the rest not providing a comment either way. In contrast the PGs 15 (83%) gave positive comments. Positive comments were as follows:

> *"it was a "[the unit] has been personally the most enjoyable unit I have studied and I believe it due to the professional nature and environment of the unit. I really enjoyed the structure of the unit."*
>
> *"good learning experience" ,*
>
> *"the environment was setup quite well; my personal development throughout the semester was a good one",*
>
> *"the environment was excellent, relaxed and laid back it wasn't intimidating, which is often the case for a lot of groups and lectures",*
>
> *"there are no negatives I can think of",*
>
> *"Overall it was a positive experience. It was great to be in a professional environment and having to work on an actual real problem. Also, it was rewarding that something you are working on would maybe be considered to be used in the real world";*

*"Overall, I found the environment to be extremely effective",*
*"The environment set up in CBISS was highly effective and beneficial to my personal and professional development.",*
*"The environment was friendly and full with technology."*
*"I … like the environment set up in this semester because it gives us a taste of how the real workplace operates and the environment"*

A negative comment from an UG student was that he "*found the environment very restrictive and inhibitive*" and believed that "*the report could have been completed in a much shorter time-frame with much better quality results*" if they had been provided with detailed marking criteria (for the report and presentation) and "*free access to the client*". This student also stated that writing of journals was not helpful and neither was any self or team evaluation as they were both "*a massive distraction from the main report*".

With regard to the meeting room setting, the space itself was organised in an open plan with cafeteria style tables and chairs around which teams could sit and talk with each table having four permanently situated laptops. There were white boards around the room and as well as projection facilities for presentations. The setting was positively commented on and generally students appreciated a common time set aside for teams to meet.

With regard to timing of events such as lectures and discussions, three (15%) UG students would have preferred "*more structure*" but only one student offered an explanation of what was meant, *"the unstructured nature of the subject made matters somewhat difficult; the seemingly random lectures and meetings with clients made it hard to concentrate on the project when other subjects required constant attention."* An interpretation of this comment was that other units had a regular weekly pattern of lectures, tutorials and so on with pre-set assignment deadlines while the project was, in comparison, rather chaotic with intermittent lectures provided as needed and client interviews that occurred on the basis of client availability rather than planned and scheduled at the beginning of semester. The work demands of the project unit were "lumpy" and relatively unpredictable and some students, not surprisingly, found this unsettling.

Lectures were appreciated by a few (15%) UGs as quite valuable, *"The group discussions and presentations were great, and provided an opportunity to talk to your team and learn valuable skills from the presentations."*

Another stated

*"The resources provided; Report writing guide, Myers Brigg test, effective interviewing, the nature of experience, effective presentations and the paper on the consultation process, to be excellent materials that delivered great value to the learning experience"*.

On the other hand two students (10%) stated that this material had already been covered in earlier units of study and so was unnecessary.

Supervisor meetings were specifically mentioned by 55% of UG students as valuable or the most valuable aspect of the environment while 28% of PGs mentioned this. As one student put it,

*"The most valuable aspects of the project were our direct communications with our supervisor, [supervisor name]. His previous experience in project and team management was invaluable in assisting me and our team with their understanding of the project."*

Other aspects of supervisor meetings mentioned as important related to understanding their project, keeping on track, and getting team and personal feedback.

Having group interviews with clients was regarded as negative by 3 (15%) students and positive by one (5%). The lack of control in directing questions seemed to be a major issue together with the expectation that if the project had been exclusively allocated to the particular student's team then the clients would have been available for more time and at the students' convenience. 22% of PG students commented that they appreciated the client interviews. There were no negative comments from PGs.

#### 6.4.2.11 Question 12 Final thoughts

Lessons learned included how to handle a project, having a good process, building credibility, being organised, carrying out tasks in a thorough manner and appreciating different perspectives of students, clients and supervisors.

Some final student comments made by students included the following:

*"I think the subject was an educational experience and I am glad to at least have had the chance to work on it."*

*"The project has been a rewarding and satisfying experience and thanks to [two supervisors] for a fantastic unit in my final semester."*
*"I really enjoyed this experience and have developed as a professional."*
*"All in all, [this unit] has been a challenging yet a decent experience for my last semester at university. I believe my experience from this subject have, to some extent, given me an insight on how a real group work operates in a real world project/scenario. Thanks [expert P] for supervising our project and giving feedback when needed and thanks [this researcher] for giving us directions throughout the semester."*
*"I will not forget the lessons learned in this subject."*

## 6.5 Summary of themes

The following is the collection of the themes from within this chapter. In many cases there has been a further abbreviation of the brief summaries provided earlier. The numbering of themes below corresponds to the numbering allocated to each theme within the chapter to allow for easy cross referencing.
1.1 The great majority of students didn't appear to take a great deal of interest in understanding their client.
1.2 The great majority of students did not appear to consider workplace culture as an issue in the project.
1.3 Nearly all students thought that their first two interviews were successful.
1.4 Criteria for success for interviews for postgraduates were understanding the problem and correctly defining scope whereas undergraduates mentioned a variety of themes such as having their questions answered, obtaining requirements and having recommendations accepted.
1.5 Few students correctly identified both problems/goals mentioned by clients while some students proposed an IT solution as the problem to be solved.
1.6 While students addressed the client's motivation for the project there were no particularly dominant themes.
1.7 Students described the project as realistic if the client as genuinely interested in solving the problem, the problem posed was a common one or if they believed a solution could be found.

1.8 Undergraduates were motivated by the idea that a solution could be extended to other parts of the organisation while post graduates were motivated because it was a real world application.
1.9 Among all students the most common control strategies to determine if the project was on track was team meetings and other team interactions. Postgraduates also mentioned client interview notes and model development while undergraduates mentioned supervisor meetings.
1.10 The great majority of students found the Myer Briggs personality test result was consistent with their own view of themselves. Most postgraduates found it helpful while some undergraduates had negative responses to personality tests.
1.11 The great majority of discussion about personality types was vague, superficial or one dimensional and some students believed difference in personalities among team members was a problem.
1.12 Most postgraduates believed that team discussions would lead to agreement on goals and standards with some stating they had explicit agreements in place. Some undergraduates stated they had explicit agreements in place while some stated they had implicit agreements. No students suggested any explicit process for distributing work fairly among team members.
1.13 The great majority of students believed they understood the work required in the project and standards to be achieved.
1.14 The great majority of students believed they have learned something positive from other team members mostly around team work mentioning the need for constant communication, flexibility and cooperation.
1.15 Students overwhelmingly found meetings with their supervisors helpful. They appreciated feedback, probing questions, guidance, focus, awareness of a wider context and assistance in keeping the project on track.
2.1 The great majority of students stated that subsequent client meetings refined details about the project but not their general understanding of the problem, scope and requirements.
2.2 Many students criticized the client for not being better prepared in their statement of the problem, scope and requirements.
2.3 A few students expressed surprise that the client’s understanding evolved and needs changed during the project.

2.4 The most cited strategy for determining the best solutions was mapping against the client's prioritized requirements.
2.5 As means of achieving project management objectives undergraduates cited team meetings, adhering to the project plan, peer review of work and supervisor meetings. Postgraduates cited peer review of work, adhering to the project plan, supervisor meetings and team meetings.
2.6 Students stated that work was shared equally among team members but provided no evidence of how this was achieved.
2.7 Students overwhelmingly thought that their team was working well although without further explanation. In contrast to the earlier journal a few students suggested that a better understanding of personality types promoted greater tolerance and that differences in personality within the team were a positive influence.
2.8 In stating what they believed was their own contribution to their team, the most cited contributions by postgraduates were attention to detail, leadership, organisational skills, team building and interpersonal skills and management and planning. Undergraduates mentioned leadership, team building and interpersonal skills, attention to detail, creative thinking and communication skills.
2.9 Since their previous journal submission postgraduates mentioned that they had learned most about issues related to management and leadership, effective communication with a focus on overcoming shyness and being able to express their ideas clearly, improving personal productivity and critical thinking. Undergraduates mentioned an appreciation of the importance of frequent and effective communication among team members, appreciation of the different perspectives provided by others, improving personal productivity and the importance of being motivated.
2.10 The most appreciated aspects about supervisors was feedback on work, keeping the project on track, clarification and development of ideas, facilitation of team dynamics and advice on personal development and productivity.
3.1 Most undergraduates thought their final presentation went well. Many undergraduates were critical of either themselves or others in relation to the presentation. Only a third of postgraduates believed their presentation went well.
3.2 Wishing they had rehearsed their presentations more was a theme expressed by many students.
3.3 Major aims for the presentation were to demonstrate their methodology and build credibility, present their solutions and focussing on the client. The great majority of

students expressed appreciation for the feedback in preparing for their presentation provided by their supervisors.

3.4 Most undergraduates thought writing their report required significant effort, with some describing it as challenging, but most of these also believed they knew what was required. Some post graduates mentioned finding the report writing as requiring significant effort. Again, many students appreciated the feedback from supervisors in preparing their report.

3.5 With regard to the final report, some undergraduates complained about lack of contribution, having trouble coordinating others, tardy contributions and work of poor standard.

3.6 Regarding the final presentation, students stated that the key ideas espoused by supervisors were the need for evidence and rationale, description of research undertaken, simplicity and clarity, omitting material on internal team functioning and issues and appropriate presentation style.

3.7 Students appreciated the feedback provided by supervisors in the writing their final report.

3.8 Some undergraduates mentioned supervisors helped clarify ideas while postgraduates mentioned helping with finding solutions.

3.9 Some students stated that their supervisor was still involved in helping to keep their project on track in the latter stages of the project.

3.10 Many students suggested that they would not need as much support in future projects.

3.11 Key ideas that students believed supervisors espoused were effective project management, being supportive to other team members, and frequent effective, communication both amongst team members and with their client

3.12 Undergraduates expressed confidence in what they were doing earlier in the project than postgraduates. After the midway point of the project no undergraduates expressed any doubts about what they doing. Most postgraduates were confident by the midway point but a few only felt confident in the latter stages of the project.

3.13 Themes mentioned by at least some students around what they had learned in the project were around the team (team work, team building and management), and working in a realistic environment (i.e. a practical problem and with real clients). Many post graduates appreciated that they were able to practically apply their academic knowledge.

3.14 The advice that most students would give to beginning project students was to try to understand the problem, issues and requirements as early as possible. Many of these students mentioned the client and client communication in some way as part of their response. Many expressed the importance of good team management and communication.
3.15 The great majority of students stated that they got on reasonably well with their team members. Only a few students attempted to discuss issues related to personality or team dynamics.
3.16 Most undergraduates and the great majority of postgraduates were positive about the professional and personal development they had undergone as a result of undertaking the project. There were very few negative comments.

## 6.6 Chapter Summary

This chapter has analysed and summarised students' reflections on their project experience. The three sections reflected the three points in time at which students were asked to reflect on their project so the responses reflect the changing circumstances and experiences of the students as the project progressed. On the whole it appears that students were very positive about their project experience, that teams get on well and effectively together, that they greatly appreciated the support and guidance of supervisors and that they learned a great deal in a practical sense about team work, project management and working with a real client in a consultancy role. One observation of a very general nature was that post graduate students appeared to be a bit more tolerant and forgiving within their teams, less critical and perhaps a little more grateful for their experience. This could be because they were a little older on average or perhaps because they were mostly international students who didn't have the benefit of industry based learning available to some of the undergraduates.

The next chapter brings together the results from the students' journals, interviews with expert analysts and literature on IS expertise. This compares and contrasts these three perspectives with the purpose of adding to our understanding of IS analysts who are in the Competency stage of their development of IS analysis expertise.

# 7 Chapter 7 Discussion of findings and recommendations

## 7.1 Introduction

The literature on novice-expert differences was examined in chapter 3 to ascertain the differences in knowledge and skills which have been observed among those who are involved in IS requirements analysis. These participants varied from real beginners who are studying courses in Information Systems or similar courses of study, those with varying amounts of experience and through to those individuals regarded as having very high levels of ability such that they are regarded as experts in the field. Using this literature the Dreyfus five stage model of skill development (S. E. Dreyfus, 2004; S. E. Dreyfus & Dreyfus, 1980) was interpreted and applied to describe a path of development of skills in IS analysis from beginner through to expert. The IS analysis skill development path assumes individuals who begin with a study of a “typical” IS or similar course, progress through their course and then eventually move into IS analysis roles within industry. This five stage model of expertise development in IS analysis interprets students working on capstone projects as beginning at the Competency stage of the expertise development model and is therefore the stage relevant to this research. As the reader will recall, students enrolled in capstone projects in their final year of their Information Systems degree were formed into teams and worked directly with clients on real world projects. Each team of students was assigned a supervisor who was considered an expert in the field of IS analysis and each supervisor was interviewed on two or three occasions to get their perspectives on how students were handling their projects, problems they faced and areas for improvement. These interviews were analysed and key points summarised in Chapter 6. Each student was asked to fill out question based journals at key points in their project and in these they described their experiences and perceptions about aspects related to their project work. These journals were analysed in Chapter 7.

This chapter combines the findings from these earlier chapters on the novice expert differences, expert interviews and student journals and draws them together to provide an holistic and detailed view of the development of expertise within the competency stage of expertise development in IS analysis. The findings from students' comments and observations from the experts informs us about how novices in IS analysis differ from experts in IS analysis in real world practice. These findings highlight the strengths and weaknesses in the students' capabilities.

If one is to improve novice performance in a specific area then one has to recognise that the expertise is highly specific to that area (Ericsson, 2002; Gobet, 2005; Thorndike & Woodworth, 1901). Novice-expert differences and expertise development that has been described in this research so far has hitherto either been stated in very general terms, was not IS analysis specific or originated from fragmented studies in IS analysis but often set in laboratory style situations and not within the context of real world applications. In contrast, this work has been set in a more realistic environment, is IS analysis specific and builds a richer picture of the Competency stage of IS analysis skill development and thereby adds significantly to the literature on novice-expert differences in this area.

Throughout the discussion in this chapter, recommendations are provided as to how the weaknesses in students' capabilities can be addressed and how novices' development toward expertise could be accelerated. Following through and/or studying the efficacy of these recommendations are obviously interesting areas for further research.

This chapter recalls the themes which have emerged from analysis and summary of supervisor interviews and student journals and links them to the novice-expert literature. The majority of this chapter is broken down into sections based on the knowledge and skills areas which emerged as the most relevant in this study: problem solving, interpersonal skills, personal attitudes and capacities, critical thinking and communication. Given the holistic nature of practical judgment, these sections are interconnected and, at times, it is necessary when discussing an idea from one area to bring in ideas from other areas.

The first section discusses Problem Solving in IS analysis. It assumes the ISAPS model and a design based approach to problem solving developed and described in Chapter 3 on IS expertise and discusses issues of students not being able to think broadly and deeply enough about the problem domain but also of not being able to think from a design based perspective which views problem-and-solution as an iterative process. The second section discusses ISD Process Knowledge and Skills and covers issues about client and stakeholder management and team management. This section could easily have been categorised as Interpersonal Skills but the perspective taken was to view dealing with clients, other stakeholders and the team as management issues while interpersonal skills as more related with a person's personal ability to get on with people on a one-on-one basis. The third section on personal attitudes and capabilities discusses the personal crises sometimes created because students are faced with uncertainty and the need to be proactive. The fourth section on Critical Thinking discusses students' abilities to utilize existing knowledge, skills or experiences and the need to establish credibility for their work through a logical and evidence based approach to their work. The fifth section on Communication Skills discusses  the ability of the students to present their understanding and work in a manner that is clear, unambiguous and understandable to the client and of a standard that the client would as accept as suitably professional.  The sixth section relates to the supervisor and issues related to supervision. The final section revisits the five stage model for development of IS analysis expertise suggested in Chapter 3. It summarises the findings of the chapter in terms of expanding upon and providing more detail about Competency stage based on the findings within this research.

In chapters 6 and 7 the responses from supervisors and students respectively were reviewed and summarised as sets of key ideas. These ideas individually identified for ease of reference. In the case of expert analysts the key ideas were identified as A1 to

A40 while for students the identification was journal based with the prefix J then the first number indicating the journal (1, 2 or 3) and followed by number of the key idea from that journal e.g. J2.7 referred to student journal 2 and the 7th key idea from that journal. In the following discussion these key ideas are referred to by their number in a way similar to the way that one would cite a research paper. Similarly, there are many recommendations made in the following discussion and for ease of reference each recommendation is numbered in the order in which appear prefixed by the letter R.

# 7.2 Problem Solving in IS Analysis

## 7.2.1 Introduction

This section looks at the IS analysis process from the perspective of determining the correct problem and method to use with the goal of arriving at a satisfactory solution which meets the problem requirements. The discussion on problem solving begins with the early stages of information acquisition in which the focus is primarily on gathering information and starts with the project brief and then moves on to the initial interviews. The second part of the problem solving discussion then deals with issues involved around holistic thinking and a design approach to problem solving.

## 7.2.2 Information Acquisition phase

The project brief and first interviews cover the early information acquisition phase of students' projects in which the direction of the project is set. The project brief is the description of the project submitted by the client initially; typically this is followed by a few interviews with the clients and stakeholders and with some background research with the aim of determining the problem, scope and deliverables. In the students' projects as part of this research this was formalised into a document that was presented and signed off by the client.

### 7.2.2.1 Uncritical acceptance of the project brief

#### *7.2.2.1.1 Recommendation R1*

**R1 When students are provided their project briefs they need to be made aware that the client's description of the problem may require further clarification and analysis and should not be accepted on face value.**

The expert supervisors believed that many students began their projects with an "assignment" based approach. They suggested that students perceived they were to be given assignments which, in the students' experience, were essentially non-negotiable, would be well described, with clear goals and clear criteria for assessment (A1, A2 and A15). This belief was also supported in several students' journals in which, for example, students complained that the client was poorly prepared with their description of the problem and goals (J2.2).

The experts' experience was that the problem described by the client in real world projects was often poorly defined and the analyst often had to work with the client to reformulate the problem, scope and project goals (A1). This has been also found in the academic and professional literature (Brennan, 2009; Chakraborty et al., 2010; Schenk et al., 1998) and with capstone projects (Geske, 2009; Gibbings & Snook, 2013). The experts' approach to the brief therefore was somewhat sceptical; they would look for some underlying business problem rather than possibly accept what could be a symptom to a problem or sometimes a solution disguised as a problem. The latter situation was mentioned by both experts D and P who gave examples of clients who stated that their problems were that they needed a new database system or new Customer Relationship Management system. These were actually the client's view of the solutions and neither the underlying problem nor even any symptoms are stated by the client.

Experts will also be looking for unstated or implied assumptions and constraints (A2); these might occur because the client assumes that the analyst has a greater understanding of the business than they actually do or the client's (mis)understanding of information technology capabilities. In contrast, students were much more inclined to accept the problem and goals as described by the client on face value. Students who have an "assignment based" approach would be inclined to assume that the client is more knowledgeable than they really are (this knowledge extending beyond the understanding of business) and therefore many students would not presume to question the client's description or at least be reluctant to do so (A2).

A problem identified by expert G was the "working backwards solution" (A5) in which the proposed solution is derived from the client's proposed deliverable or objective. This represents an uncritical acceptance of the client's request. There is effectively no attempt to understand or question the problem which the deliverable or objective is meant to address. An example of such a scenario might be that the client states that they have information problems in the running of their business and requests some form of database package to solve the problem. The students fix on what the client requested, a database package, and thereafter they search for appears to be a suitable database product for the client. The client may well be quite supportive and enthusiastic because the team is providing what was requested. However, there has been no proper consideration of the problem from an information systems perspective; the client's information problems may only be symptoms of the real problem (A2). The solution, if implemented, may have not improve the client's situation or even make it worse.

The working backwards solution is also a failure on the part of the analyst to try to understand the problem holistically. In this case the "solution" is provided by the client rather than the analyst and stated problem is not questioned. Here, the perspective on the analyst –client relationship is suggestive of an employer –employee in which the employee simply obeys the orders given by their employer. This potentially suppresses the knowledge and skills of the analyst and so the analyst does not provide the full value of their expertise.

##### *7.2.2.1.2 Recommendation R2*

**R2 At the beginning of the project students need to be made aware that the responsibility for the success of the project lies largely with them and not with the client or their supervisor.**

One of the steps in preparing students for capstone projects is to try to move them out of the idea that they are doing an assignment that just happens to be somewhat larger in scale than they have otherwise been accustomed. In the situation that there is one team working solely for one client this is much easier because it is obvious that every decision or action by the team impacts on the project and has consequences for which they are directly accountable (A1, A25, A26, A31). This is appropriate for novice stage in the Dreyfus model (S. E. Dreyfus, 2004; S. E. Dreyfus & Dreyfus, 1980) as this is meant to be the point at which the novice accepts that decisions and actions have real consequences. Hence the novice becomes emotionally engaged.

In situations where multiple teams work on the same project that direct relationship is significantly diminished. The risk of lack of engagement can be mitigated to an extent by introducing as much direct client and stakeholder involvement as possible so that students can interact and thereby establish a connection with them. One could also introduce a competitive element to find the best solution. This is relatively common in engineering areas, e.g. (Paulik & Krishnan, 2001), and mirrors the competitive tender process or a review where teams don't just present their work but have to actively promote the originality and practicality of their solution and therefore demonstrate being worthy of implementation. These types of approaches may help to increase emotional engagement.

#### 7.2.2.2 Laying the foundation for the analyst-client relationship with students

##### *7.2.2.2.1 Recommendation R3*

**R3 Before meeting clients, discuss the client-analyst relationship with students and suggest appropriate models for working with the client.**

The difference in mental model(s) of the analyst's role is a significant difference between experts and novices (A31, A36, A37, A38). It is recognised that exceptional analysts are people oriented and able to work with and lead teams (Vitalari, 1985; Wynekoop & Walz, 2000). As novices start working on real world projects, they may draw on and attempt to apply relationship models with which they may be familiar or have observed e.g. employer-employee, teacher-student and even parent-child which, however, are not a suitable basis to build upon for someone wanting to develop into an expert analyst.

The students in this research were encouraged to think of themselves as consultants. This is the model relevant to the expert supervisors and suggested in client based capstone projects and explicitly stated by West (2011) for client based capstone project students in advertising but little addressed in literature related to capstone project work. Attempting to create a more appropriate mind set (and unlearning less effective ones) among novices can be aided through preliminary meetings which discuss the different possible relationships between consultants and clients e.g. (Schein, 1990) and emphasizing that novices need to be prepared to assess each situation on a case by case basis.

In a typical situation with many project teams involved in the capstone unit more formal sessions such as a lecture or tutorial are probably the most efficient way to present this information and are very much appreciated by some students (J3.16). A general discussion has the advantage of exposing them to the variety of potential relationships and the opportunity for students to ask pose potential problems and issues. If they already have their project brief at this point then they can attempt to interpret the information in the light of their particular client; these can make for highly relevant examples for general discussion. Supervisor meetings can help to further clarify and refine students' initial ideas and thereby support and reinforce the more appropriate models (J1.15).

### 7.2.2.3 Appreciating client and analyst knowledge and skills

#### *7.2.2.3.1 Recommendation R4*

**R4 Encourage teams to make explicit the knowledge and skills of each team member and how the skills may be utilised on the project.**

Novices need to appreciate that their clients will have some knowledge and skills (mostly related to their business or organisation) which are relevant to the project but not others (mostly related to information systems and technology).

Novices should recognise and appreciate the IS related knowledge and skills they bring to their projects e.g. as providers of IS and IT knowledge and skills in analysis, development, project management, IS applications and so on (A7). A useful exercise is for novices is therefore try to determine the client's strengths and weaknesses. This creates a useful contrast between them and the client and highlights why and how they are needed and complement each other. With regard to students, knowledge transference from one context to another (out of the academic area and into the practical) is not automatic (A11, A17). One way to "prime" and mentally "activate" their knowledge and skills is to encourage them to analyse their project brief (and any other relevant information gathered) with a view to purposefully considering the academic and other knowledge and skills they have acquired that they can bring to bear in the project. These strategies are consistent with Merriam and Leahy (2005) who suggest participants be actively involved in reviewing the knowledge and skills required for their project and a supportive environment which encourages them to apply their prior learned knowledge and skills.

### 7.2.2.4 Importance of background research

#### *7.2.2.4.1 Recommendation R5*

**R5 In preparation for client meetings, students should be encouraged and expected to do relevant background research.**

One difference between experts and, at least some, students was that the experts expected that there should be some initial background research prior to meeting the client so as to become familiar with the project and problem domain especially if there was little or no prior experience in that area (A3). Expert D, for example, would go through the project brief quite carefully highlighting key words or ideas and suggest areas for investigation if students did not volunteer them. This might be to do with the organisation or organisational unit, the type of business the organisation conducts, the problem posed and so on. One justification for doing this research which students more immediately accept is that it makes the subsequent client meetings more effective. The other justification which is less obvious is that this familiarity helps to establish the client's trust with the analyst because the analyst appears knowledgeable and has some initial understanding of the client's situation (A3).

Discussing what to work on regarding possible background research with novices can be very instructive to novices. Demonstrating a proactive approach may be a useful for those novices who adopt the attitude that they will do something only if it is immediately and explicitly required. It also suggests how a more experienced analyst approaches this research by suggesting what to research and to what extent; this can be insightful for those students who may be genuinely at a loss as to where to start in conducting any background research. Apart from assisting in the early stages of the project, the material gained through the background research can be justified on the basis that should form part of the final report to the client so it is better done sooner than later.

### 7.2.2.5 Developing a more strategic and holistic approach to information gathering

#### *7.2.2.5.1 Recommendation R6*

**R6 Students need discussion about and support with adopting a strategic and holistic approach to gathering information, in particular how to develop and structure their questions for their early interviews with clients, and means by which they can validate their findings.**

An observation about students and the client interview process was that many students had relatively poor strategies in terms of asking questions. Students sometimes ask a series of questions pitched at varying levels of abstraction or on varying topics in a manner which may appear somewhat random (A8, A11). Mackay and Elam (1992, p. 151) suggested that novices tend to use a bottom up procedure in their information gathering which lacks a comprehensive plan and which, according to Vitalari (1985), concentrated on "*tasks, processes, information flows and storage*". Some students in this research acknowledged that they did not know what questions to ask (J1.3). This may be a result of novices sparse knowledge (Atwood et al., 1979; D. Batra & Davis, 1989; Sutcliffe & Maiden, 1992) about the problem domain in particular, business and organisational knowledge, or how to go about the problem solving process or simply not being systematic and disciplined in their approach.

Manifestations of this were found in students' journals where, for example, there was little discussion about the client and other stakeholders, their motivations for and interests in the project (J1.6) and the nature of the workplace culture (J1.2). These can be considered important aspects because they reflected these stakeholders' values and priorities and impacted on the types of solutions that would be considered acceptable and hence to functional and non-functional requirements. These considerations affect the project goals, the definition of success from the client and stakeholders' perspectives and help to reduce the potential search space. The bottom up procedure may, to an extent, also be a consequence of previous assignment based work in their academic studies if they involve situations where contexts of assignments (and other similar tasks) are limited, the premises of an assignment are non-negotiable and students are expected to demonstrate their ability to follow instructions and rules rather than to question them. On the other hand, the experts' emphasis on the client, the client relationship, understanding the client (A10, A25) and then understanding the reasons and assumptions underlying the project suggest the experts' alertness to these meta level aspects.

When they first reported in their journals, nearly all students thought that their first interviews were successful (J1.3) but criteria for success varied. Virtually all postgraduates were more concerned about understanding the problem and correctly defining scope while undergraduates were more superficial and mentioned having their questions answered, obtaining requirements and one criterion suggesting that if their recommendations were accepted then the interviews must have been successful (J1.4). However, most students only identified one of the two key problems mentioned by the client and some students proposed a particular type of IT solution (never mentioned by the client) as the client's underlying problem (J1.5). The expert supervisors' observations were that students often didn't absorb as much information as they thought they actually did and that the problem was not as well understood or scoped as well as they may have believed (A1 to A8, A12, A13). Apart from simply having rather weak criteria for success (e.g. the client answered the questions posed) the novice–expert literature suggests that novices' knowledge structures are relatively superficial and sparse (Atwood et al., 1979; D. Batra & Davis, 1989; Sutcliffe & Maiden, 1992) so it can also be speculated that students' over confidence regarding the interviews could be attributed to them not being aware of the information that they were missing or had misinterpreted.

When preparing for the interview with the client, students and experts are inclined to approach the interview with quite different mind sets. The experts in this study went in prepared to question the entire premises of the project brief while the student were inclined to accept the premises of project brief and instead sought clarification and detail (A1, A2). Given the different mind sets, the types of questions and even the tone of the interview set by the experts and novices if left to themselves are likely to be quite different with the expert's approach more questioning, challenging and high level while the student's is accepting and low level. Some students can be so "locked in" to the original project brief that when the client changes the project in some regard in the interview they can become quite confused (A5, A6).

If students are inclined to simply accept without question the project brief as originally given by the client then a consequence of this is that questions would be based around clarification and details (e.g. processes, data stores and information flows) which was observed by Mackay and Elam (1992) and Vitalari (1985) rather than on the higher (more abstract) level aspects such as questioning the purpose of the project (e.g. business strategies, motivations, goals, impact of or on other parts of the business etc.). If the client were to have a significant change of mind about the project and therefore depart from the original project brief then one imagines that this would naturally throw out whatever set of questions the students might have and probably leave them floundering in an interview situation (A6).

A problem observed by the expert supervisors was that in some cases students became "prematurely solution focussed". This was to fix on a particular solution based on very limited understanding of the particular problem domain characteristics and thereafter not be willing to reassess it (A4) in the light of subsequent knowledge. For example, one team supervised by Expert P decided on a meeting management solution immediately after reading the project brief with, according to Expert P, obviously little regard for the organisational context (A4). The solution proposed by the team was based on one student's earlier experience of a meeting management system solution implemented for a small organisation where meetings were relatively informal and several of the participants of these meetings were moving from place to place internationally. The current organisation mandated much more formal procedures, dealt with large quantities of sensitive information and participants to meetings were based on the same small campus or close by. When their proposed solution was mentioned to the client and stakeholders early in the project it was received with little enthusiasm which was seen by the team as typical of users being unwilling to change established procedures. According to expert P, the team was forced, reluctantly, to investigate other solutions and although the final presentation and report conformed to the required structure of problem description, compilation of requirements and comparison of different candidate solutions the team's final recommendation was still their original solution which was quickly rejected by the client and stakeholders as inappropriate (A4).

Premature solution focus is a failure in understanding the problem holistically i.e. the organisational context hasn't been explored thoroughly enough. Instead of using the proposed solution as a means of exploring the problem domain as suggested by taking the design perspective, the exploration stopped when the solution was proposed. It may also be suggestive of an inappropriate perspective on the analyst–client relationship. It might signal a relationship model something on the lines of "I am the expert here, you are not and so I will tell you what you need" rather than a more collaborative model. In the example earlier the team expected the client and users to adapt themselves and their processes to the proposed solution (J2.1). This might have been feasible but the team didn't provide a credible argument that it was, in fact, a satisfactory solution based on sufficient exploration and understanding of the problem domain.

If students are encouraged to adopt a style more like that of the experts then the types of questions are naturally pitched at a different level and more universally applicable. If the client has a change of mind then this is less likely to throw off students because the same types of questions can still be applied. Whether all students can handle this approach, however, is an interesting question because thinking at this level is recognised as being difficult even for those at the competency level of the Dreyfus model (Adelson & Soloway, 1985; Dinesh Batra & Davis, 1992; Mackay & Elam, 1992, p. 151; Sutcliffe & Maiden, 1992).

Within the context of the project, the problem of the bottom up thinking can be improved through provision of a lecture or tutorial which guides students to think more from a top down perspective, students doing adequate background research and then thoughtful development of interview questions. Supervisor meetings can support these activities through discussion aimed at clarifying and refining ideas (A8, A9). A longer term solution is teaching holistic design based thinking in earlier units of study which is then practiced in assignments or smaller projects.

#### *7.2.2.5.2 Recommendation R7*

**R7 Prior to beginning the capstone project, provide students in earlier units of study with opportunities to define, scope, deliver and assess their own projects.**

From a longer term perspective, an interesting suggestion by J. W. Thomas (2000) is to include work prior to beginning the capstone project (e.g. in prior units of study) which provides students with the experience of defining and scoping problems which they also solve. The work needs to be moderated by academic staff to ensure that any problem is appropriate, its scope reasonable and that there is an appropriate outcome. An important learning outcome of this experience is to expose students to the difficulties of having to work out a problem, determine what to achieve and appropriate standards by which to judge the result. From the perspective of preparing students for capstone projects this may give students a better insight into the process that they and their client will need to undergo. Although their work is aimed at project based learning with secondary school students, Mergendoller and Thomas (2000) provide useful advice and insights on conducting such project based work.

### 7.2.2.6 Developing a disciplined and thorough process of interviewing

#### *7.2.2.6.1 Recommendation R8*

**R8 Supervisors should discuss the interview process used by the team and review their subsequent analysis and findings of interviews with a view to discovering and highlighting any ambiguities and areas to follow up.**

Many students (though not all) did not appear as disciplined and systematic as they could be (according to the observations of the expert supervisors) in preparing for, recording, reviewing and analysing and later validating the information obtained from interviews clients and stakeholders (J1.9, A30). This is consistent with the finding that experts are generally systematic and disciplined in their approach (Dinesh Batra & Davis, 1992). In some cases this was simply because students didn't put much care or effort into the process. These students didn't appear to see the importance of putting in the effort; possibly there was a belief or assumption that the required information about the project would be available in some other way even if they didn't find out what they needed from the interview. Interestingly, students were often more concerned that there was agreement amongst themselves as to the understanding of the project or tried to confirm their understanding with their supervisor (who normally was not present at the client interviews) but many were relatively poor at taking up the opportunities to review their understanding directly with the client (A30).

By the time of their second journal, many students suggested that they hadn't got as much out of the client and other stakeholder meetings as they could have (J2.1). The undergraduates were more inclined to blame the client for lack of organisation or forethought whereas postgraduates were more likely to suggest that it was their own lack of understanding. Clearly, from both the viewpoint of the experts, literature (e.g. (Brennan, 2009; Chakraborty et al., 2010; Schenk et al., 1998)), the ISAPS model and literature on design the task of defining the problem, scope and requirements can be a "messy" one in which there is evolution of understanding. Unless there is some gross negligence or ulterior motive at play then neither the client nor the analyst could really be said to be "at fault" during that task and, in fact, may be counterproductive if either party has unrealistic expectations.

Discussion about the client interviews should be aimed at

(1) ensuring they have effective and realistic goals in terms of what they are trying to achieve in interviews (A8, A9, A15)
(2) emphasizing the need for appropriate background research based around the project brief and problem domain (A3)
(3) reducing the impact of sparse knowledge structures (Atwood et al., 1979; D. Batra & Davis, 1989; Sutcliffe & Maiden, 1992) by taking the time prepare suitable questions emphasizing an holistic approach and using aids like checklists
(4) ensuring that interviews are recorded appropriately and then
(5) analysing the acquired information to extract as much information as possible (A13).

These ideas and skills can, of course, be taught and practiced in earlier academic studies in which there should be more time to develop a solid grasp and fluency in terms of operating at different levels of an abstraction, adopting a questioning and critical approach, interviewing techniques, analysis etc.

Novices' interviewing process within the project could be better managed and controlled if they were required to describe (either verbally or in written form) their preparation for interviews, their interview questions, summaries of interviews, subsequent analysis and items for follow up (A9, A10). This does not represent any more work for students than they should have undertaken and from an academic perspective can become the focus of discussion in supervisor meetings and provide feedback (A12, A13, J1.15). As a minimum, each team should be required to document and submit fairly detailed interview summaries. Having multiple points of feedback for students is regarded as valuable by several authors (Brooks & Ammons, 2003; Hansen, 2006; McKendall, 2000). Unchecked, many teams will produce very sketchy interview notes and when students are individually quizzed about interviews they often do not have clear recollections of important details or they may even have contradictory recollections of what was stated. Students can be required to send interview summaries to the interviewees for comment. This is provides an opportunity to get further client feedback.

#### 7.2.2.7 Academic and supervisor support

In this information acquisition phase, expert supervisors provide support by providing students with suggestions for information that could be explored, that they believed might be missing, by asking challenging questions and by highlighting or clarifying issues. Furthermore, as the Dreyfus model (S. E. Dreyfus, 2004; S. E. Dreyfus & Dreyfus, 1980) of expertise development suggests, one of the reasons why novices can find their task mentally exhausting is that aspects of the problem domain may all appear equally important, making the task appear very complex (i.e. they are "unable to see the wood for the trees") whereas the experts were better able to prioritize and then concentrate on key issues while deferring others and thereby keep the project progressing forward. It is in all these regards that experts support novices (A26). This support was acknowledged by students (J2.10). However, one can always expect some missing, misunderstood or misinterpreted aspects of the project may not become apparent to students until they are researching solutions which may cause them to reflect back and question and clarify their earlier ideas and assumptions. It is not surprising that many students suggested that they only fully came to understand their project midway (rather than almost immediately) or some cases towards the end of the project (J3.12).

### 7.2.3 Holistic and design based thinking

#### 7.2.3.1 Introduction

It is recognised that experts are more holistic and systematic in gathering information (Dinesh Batra & Davis, 1992). Adelson and Soloway (1985) suggested that they are also able to structure the problem into different levels of abstraction, allowing them to simulate the system. The research on design suggests that designers with specific experience of the problem type approach the design task through solution conjectures, rather than problem analysis. Observation of expert analysts in this research suggests consistency with all the above, but with a specific IS perspective. The experts approached the original project brief by exploring the client‘s original description with a view to looking beyond symptoms and details to look for a high level (i.e. sufficiently abstract) description so that the situation could be classified as a problem type relevant from an information's systems perspective (e.g. experts in this study would describe the problem in a project brief as a “document management” problem, “workflow” problem or a “matching” problem) which would trigger solution conjectures about the types of solutions that might be appropriate (A2). The appropriate type of solution would be considered against the wider problem domain (e.g. characteristics of that particular organisation) and could trigger particular types of questions (e.g. regarding capabilities of users, IT infrastructure, legal issues, workplace culture etc.).

This approach is consistent with the underlying structure of expert thinking suggested by Mackay and Elam (1992) but with an IS perspective. From the areas of IS Analysis knowledge and skill outlined in Chapter 3 the knowledge and skill area which appears to be particularly relevant is IS Applications Knowledge and Skills, suggested by Iivari et al. (2001) as a distinctive skill in the Information Systems area. IS applications relate to both problems which have been observed in organisations and the solutions which have been developed to deal with those problems. From the design perspective of the interplay of problem and solution as a way of understanding and solving problems, it should not be too surprising therefore to find that IS applications knowledge should strongly influence the way in which IS analysis experts frame their thinking about business problems. Vongsavanh and Campbell (2008) found that there was an area of overlap in terms of the activities between business analysts and systems analysts. What is suggested here is that IS analyst experts don't just simply operate in this area of overlap but that they have a way of thinking which has become specialised for the area and gives a distinctive perspective on business problems different from either the “pure” business analyst or systems analyst.

#### 7.2.3.2 Mental simulations and transfer of learning

##### *7.2.3.2.1 Recommendation R9*

**R9 Supervisors should encourage students to think about their prior experiences beyond their knowledge and skills acquired in academic studies and how these might apply in their project.**

The literature suggests that experts are able to mentally simulate solutions (Adelson & Soloway, 1985; Curtis et al., 1988; Raymonde Guindon, 1990; R. Guindon & Curtis, 1988). As was expected, in this study the experts often performed mental simulations and would make use of prior experience or from analogous situations in order to so. For example, expert P described having previous experience of software systems that clients believed were inadequate but the solution only required changes to business processes to fully utilize them or that the client indicated a need for a database but the situation suggested document management was the real issue and could be solved utilizing document management system (A2). The experts are working through one or more mental models to foresee an outcome and also switching between levels of abstraction from consideration of implementation of a type of solution to a concrete mental simulation of the solution in operation with a particular user and using this thinking to guide their thinking. Mental simulations appear to be a combination of conceptual modelling, replays of past experiences together with drawing from analogous situations. In contrast students had greater difficulty in foreseeing the implications of particular information on the project or mentally simulating possible systems in operation because of their limited experience (A9).

Novices clearly don't have as much experience as experts and so have much less to draw from. However, they often underestimate or even ignore their own experiences and the observed experiences of people they know. For example, they are prolific consumers of technology based applications (mobile phones, applications on the internet, Facebook, Twitter, computer games and so on) and hence possess a great deal of conscious and unconscious knowledge as users of those applications. Encouraging novices to tap into that experience by helping them to recall it and encouraging empathic thinking (e.g. with questions such as "How would you feel if you were placed in this situation?", "What is a similar application you have used?" etc.) can help them to potentially see applications or foresee consequences (A17).

*7.2.3.2.2 Recommendation R10*

**R10 Encourage students to make use of conceptual modelling and simulation and to demonstrate thinking from a high level design perspective.**

From an academic perspective, conceptual modelling (e.g. database design) is an excellent training ground for working with abstraction and abstraction levels and it is clear that those novices with solid conceptual modelling skills cope better in this regard than those whose skills are relatively poorer (Sutcliffe & Maiden, 1992). It is an area in which students have difficulty but can be developed with training and practice and is a skill necessary in developing expertise (I. L. Huang & Burns, 2000). However, the emphasis should be on using conceptual modelling as a tool for design and problem solving rather than simply as a passive exercise in understanding (Simsion et al., 2012). There were two ways of thinking demonstrated by students which were noted by the expert supervisors. These could be improved when viewed from the holistic design perspective. They are designated here as “untested assumptions” and “passive requirements gathering”.

7.2.3.3 Untested assumptions

*7.2.3.3.1 Recommendation R11*

**R11 Students should use relevant checklists and other such aides which are available to explicitly demonstrate that they have been comprehensive and thorough in the research and information gathering.**

A problem mentioned by experts was students’ “untested assumptions” (A7). These assumptions could be about any aspects of their project and could be made consciously or unconsciously. These assumptions influence their choices (A6) and may significantly impact project outcomes. An example of such an untested assumption which often occurred was about the client’s budget. Some students assume that the client wants to pay as little possible for a solution, then decide on a budget probably based their own experience of what is a small budget and thereafter limit the range of candidate solutions considered. Some others might assume that the client will purchase whatever is recommended (i.e. the assumption is that the budget is unlimited) and propose an expensive solution well beyond the client’s budget or foreseeable needs. The experts were careful to consider budget constraints but were also cognizant that clients might consider solutions exceeding a stated budget limit if the client could perceive genuine “value for money”. Other untested assumptions might relate to the supporting IT infrastructure (e.g. can or will the IT infrastructure support the proposed solution), user capabilities (e.g. will the users be able to use the proposed solution), user characteristics which define what is considered acceptable (e.g. will professional staff accept a solution that might restrict their ability to make decisions in their domain of expertise) and so on (A7). If assumptions are left unexplored or untested this may lead to poor solutions (J2.1). Given novices sparse knowledge structures they may well miss these significant aspects of the problem domain without being aware that they are doing so.

The use of checklists or such guides can alert novices about potential areas to explore. However, checklists are typically “all purpose” tools and as such may cover aspects that are not necessarily relevant or they may miss aspects which may apply in a particular project. Discussions between the team and supervisor may help to draw out untested assumptions missed by the checklists but these discussions are also valuable because they can provide discussion on the assumptions, their relevance to the project and their potential impact on the project outcomes.

#### 7.2.3.4 Passive requirements gathering

##### *7.2.3.4.1 Recommendation R12*

**R12 Students should demonstrate that they have explored a wide variety of relevant requirements gathering techniques e.g. interviewing a variety of different stakeholder groups, applying standard requirement checklists, questionnaires, viewing relevant industry publications, visiting similar organisations, reverse engineering potential software solutions to determine requirements etc.**

Students can be rather passive in terms of requirements gathering and need to be proactive in this area (A7, A16). Inadequate requirements gathering is a recognised reason for software system failure (Davey & Cope, 2008; May, 1998; Verner, Sampson, & Cerpa, 2008). There are two aspects to being passive in obtaining requirements. These two aspects could be summed up by lack of diligence and lack of creativity.

Lack of diligence in requirements gathering can be related to too much reliance on the client or stakeholders to simply provide the analyst with the comprehensive list of all the requirements. Students may simply ask the client rather general questions about their requirements, expect the client to tell them everything of relevance (A3) and largely accept whatever is mentioned as the (entire) requirements list; other requirements are either assumed (consciously or unconsciously) or missed by the students .

An obvious point to first make is that the client and stakeholders will not be aware of the requirements that might be relevant to a potential IS solution and therefore not in a position to state them (C. J. Davis, Fuller, Tremblay, & Berndt, 2006). This expectation may be based on an assumption made by students that the client and stakeholders are more knowledgeable than they really are. Ultimately, in an analyst-client relationship it is the responsibility of the analyst to ask the right questions or as expert G put it *"otherwise why would they need us?"* (A20, A21). The questions must be more specific and probing (especially about non-functional requirements which are less tangible) so as to "extract" those requirements from the minds of the client and stakeholders; requirements held consciously can be obtained simply by asking the right questions while those held unconsciously may require more probing questions and discussion. Another expectation by some students is that the client should be better prepared and organised for the project (J2.2). This amounts to an (inappropriate) assumption by the students about the nature of the analyst-client work relationship (A10). Expert G summed up the real world situation when he commented that clients were very busy running their business and that, "*if they had time to do this they would be doing it themselves*" which students may not appreciate.

*7.2.3.4.2 Recommendation R13*

**R13 Students should regard an aspect of their role as analysts is to bring ideas to their client that they may have not previously considered or not fully appreciated.**

Creativity and innovation are important factors in the requirements engineering potentially in conflict with the more utilitarian approach which seeks to deliver a more pedestrian outcome that satisfies the client's basic needs (Hoffmann, Cropley, Cropley, Nguyen, & Swatman, 2007; Kauppinen, Savolainen, & Mannisto, 2007; Maiden & Robertson, 2005; Maiden, Robertson, & Robertson, 2006; Nguyen & Shanks, 2006). With a holistic design based approach it is suggested that creativity and innovation emerge naturally. With the benefit of relevant research and as potential solutions are considered, new functional or non-functional requirements may well emerge which were not previously considered by the client, stakeholders or analyst. Lack of creativity, in this case, is an unwillingness to consider going beyond the original boundaries set by the client. Without creativity these can easily be discarded as "out of scope" and opportunities missed. For example, the client may have asked for some way to manage a problematic business process in his organisation. In the course of research the analyst finds that there are workflow management systems that satisfy the client's immediate requirements but there are others that offer far more features and flexibility. Suggesting these potential extra features to the client may change the client's thinking and these can be added to the list of requirements if appropriate.

As is suggested by the iterative nature of the ISAPS model, this feedback from the research and solution phases may trigger reflection not only about the scope but also about the original problem and deliverables and a change which subsequently leads to a more effective, and even radically different, outcome for the client. This creativity on the part of the analyst is consistent with the ideas such as developing a partnership relationship between client and analyst mentioned that expert G (A16, A36), the analyst "value adding" proposed by expert D (A5, A21), and a design approach to IS analysis mentioned earlier.

Finding potentially new and valuable requirements is an outcome of the design process in which findings from the activities of researching solutions and selecting candidate solutions provide positive feedback to earlier stages. As has been suggested, lack of creativity may reflect something personal about the novice but may also reflect the novice's analyst-client model if the novice is unwilling to work truly collaboratively with their client.

#### 7.2.3.5 Getting stuck in information gathering

##### *7.2.3.5.1 Recommendation R14*

**R14 Supervisors need to actively monitor their teams so that they are aware of their progress and then help them to get back on track if they are becoming significantly unproductive or stalling in some way.**

In design areas novices it has been found that novices can become stuck in information gathering and problem definition (Cynthia J. Atman et al., 2007; Cynthia J. Atman et al., 2005; Christiaans & Dorst, 1992; Kolodner & Wills, 1996). In this study, all teams eventually went past this stage to find and recommend solutions but it can be reasonably argued that the presence of an expert supervisor with each team ensured that each team was guided or pushed through this potential trap. However, the potential for a team to become stuck was evident with expert supervisors noting that sometimes teams went around "in circles" (A26) getting confused by the complexities and unknowns. Sometimes students spent a great deal of time investigating but then not producing tangible results (A28); in this case it might be because the team is reluctant to produce something tangible until all the investigation is completed and settled. However, this might not be feasible or even the best approach when viewed from a design perspective. Teams are expected to be proactive and show independence but at the same time it has to be acknowledged that they are still novices and need guidance. When it becomes clear that some intervention might be required, supervisors have to be prepared to step in to move the project along. Students acknowledged and appreciated that their supervisors helped them to stay “on track” (J1.15). The supervisor helps teams by clarifying issues (J3.8), perhaps highlighting which issues appeared to be more important (i.e. helping them to “see the wood for the trees”) and suggesting the issues that they could defer while they focussed on others. At other times the supervisor might simply encourage exploration of some path to see what emerged. Many students explicitly mentioned the value of supervisor meetings (in a variety of ways) throughout their projects and how they helped to keep their projects “on track” (J1.15, J2.10, J3.9). The other influence that helped students to “push through” was the discipline imposed by having to show some progress at weekly supervisor meetings (J2.4, J2.10). While discussion is valuable, production and review of written work or presentations which support final goals such as problem descriptions, scope statements, requirements documents, interview summaries, reviews and so on should be required. Wojahn, Dyke, Riley, Hensel, and Brown (2001) found that students are often inclined to see these as distractions from the “real work” as but they emphasized that is great value for the students themselves in developing these tangible communications. Students are forced to clarify their ideas; it highlights gaps in thinking and fosters innovation and creativity. These tangible products also help to engage the stakeholders (client, supervisor and others) by providing concrete items for discussion.

#### 7.2.3.6 Promoting holistic design based thinking

##### *7.2.3.6.1 Recommendation R15*

**R15 Within prior units of study use realistic or real world case studies to demonstrate the issues involved in a holistic and design based problem solving approach.**

This section sums up with the suggestion that students face two issues with the holistic design approach. The first issue was noted by Venable (1995) but stated in a general way that novices lack problem solving heuristics. Students have acquired a great deal of academic knowledge but not necessarily a way to apply this knowledge from a real world problem solving perspective. They may well be able to provide an appropriate solution when a problem is carefully presented in an easily recognisable manner in a relatively “sanitized” context (i.e. academic exercises). It is suggested here that problem solving in the IS analysis area is not presented sufficiently (if at all) with a holistic design approach.

Real world situations are typically messy and these situations are presented by clients and stakeholders who don’t know how the situation “should” be presented i.e. in a way that an IS analyst might think about the situation. A design perspective provides an approach to dealing with these messy real world situations. Without it students potentially face various stages of “analysis paralysis” (Cynthia J. Atman et al., 2007; Cynthia J. Atman et al., 2005; C J  Atman et al., 1999; Christiaans & Dorst, 1992; Kolodner & Wills, 1996).

The other issue is students’ limited judgment (i.e. through lack of experience) in being able to “see” the world from IS perspective e.g. to be able to see “through” a client’s description of their situation and perceive it as a “document management” problem or “workflow” problem and not simply a confusing mess. Judgment also comes into play when deciding the extent to which one needs to explore the problem domain, deciding the issues which are the key ones and which are not, when one should stop searching for solutions because the one we have is “good enough” and so on. These are key areas for development of expertise in IS analysis.

*7.2.3.6.2 Recommendation R16*

**R16  Develop and incorporate a unit on advanced analysis and design for the IS area for those wanting to specialize in IS analysis.**

In IS curriculum guidelines (Gorgone et al., 2006; Topi, Valacich, Wright, Kaiser, Nunamaker Jr., et al., 2010) the idea of design is not presented from the sophisticated perspective taken by expert IS analysts solving business problems. Design should be approached with a view to providing underlying principles and thoughtful discussion about how it should performed in the context of the IS area. For IS analysts the organisation is the space in which they typically operate and solve problems and the design perspective should recognise that in the IS area the building blocks are existing and leading edge IS software applications, communication technologies and platforms. Other fields which are involved in the development of other types of artefacts e.g. the engineering fields, architecture etc. view design as a fundamental to their field. The design perspective is specialised to their field and its importance is not questioned.

Their aim is to develop students who can design using artefacts to solve problems in a holistic way using the techniques and building blocks belonging to their field. In contrast, in the IS area design is typically presented in a piecemeal fashion with each "piece" operating in a very limited context and/or at a low level (e.g. a web page, a process, a data model). A reappraisal of design based thinking and teaching in IS analysis appears to be very worthwhile and appropriate implementation of ideas would lead to better prepared analysts.

## 7.3 ISD Process Knowledge and Skill – People management

### 7.3.1 Introduction

This section looks at the differences in approach between students and experts to managing people. It divides into two parts with the first part discussing team management of those parties external to the team (i.e. clients and other stakeholders) and the second part discussing teams' internal management of their team members. A key issue is that students don't necessarily have a suitable or effective mental model of the analyst-client relationship. Partly as a consequence of this, they don't communicate effectively with the client and they don't understand the need for managing the client nor how to manage the client as the project progresses. Managing the project process and the team also emerged as issues as students grappled with projects that were more complex and over a longer time frame than they were familiar with. This necessitated greater and more consistent management than they had to apply in the past.

### 7.3.2 Client and Stakeholder Management

The importance of client and stakeholder management is acknowledged in the academic literature (Baccarini, Salm, & Love 2004; Keil, Cule, Lyytinen, & Schmidt, 1998; Petter, 2008). It is recognised as an aspect of ISD Process Knowledge in terms of project management, involves Interpersonal Skills and because it requires speaking and writing clearly also comes within the ambit of Communication Skills. As was indicated in the chapter on IS Expertise Characteristics, experts placed high importance on teamwork, building trust and communication. They were also cognizant of the social and political aspects involved in projects. However there is little academic literature on the differences between novices and experts in the way they interact with clients and stakeholders other than to suggest experts demonstrate significantly superior understanding and skills in these areas and that, by inference, novices would display these to a lesser degree.

#### 7.3.2.1 Developing more effective analyst-client role models

##### *7.3.2.1.1 Recommendation R17*

**R17 The analyst role should be discussed with students before meeting their client so as to prepare them for their first meeting**.

Possibly the best description of the role the students played in their projects is well described by the term "consultant" which captures the idea of someone coming in to provide professional advice or service over a limited time frame. How a consultant supports and interacts with a client varies from project to project depending on the client and may alter over time within a project and so the consultant must be prepared to adapt to the circumstances. The use of the consultant model in capstone projects is described by West (2011) and he suggests that important characteristics of that model are that the client retains ownership of the problem and also determines if the project ends successfully or not. This then leads to expectations of delivering a satisfactory outcome for the client at a (reasonably) professional standard. In this type of model the analyst-client relationship becomes central and should not be underestimated in student capstone projects where students must work directly with clients. Consistent with that theme, the consulting model of the analyst-client relationship was emphasised by all the expert analysts.

With regard to students, on the whole they establish reasonably productive relationships with their clients over the life of the project although they often had shaky beginnings (A10, A37) because they began with inappropriate assumptions about the role they were to play. These relationship assumptions were observed and noted by the experts (A10, A37) but typically only implied by students when they wrote about their interactions with or expectations (J2.2, J2.3) of the client. However, as the project progressed, their approach to the client adapted so as to suit the client's needs and circumstances. Some initial assumptions about the role that students appeared to display were, for example, students who saw the client as a variant of teacher giving them an assignment; others seeing the client as an employer who would direct them as to what needed to be done and they needed to comply; a few students were inclined to see themselves as information systems authorities who would decide what the client needed and then pronounce their advice. The experts preferred to view the relationship more as a partnership or collaboration because they viewed this as the most productive relationship although all stated at some point or other that ultimately the client, as the one paying for the project, was the one who made the final decisions.

An example of this misunderstanding of the client-analyst relationship was demonstrated earlier with the expectation that the client would provide a clear and accurate brief (A1 and A15) and in many cases students expressing annoyance that the client was not “better prepared” with the project description (J2.2). This would suggest that they believed that the client was somehow delinquent in their preparation and that they could and should have provided a better thought out description. These students clearly missed the idea that the client may not have the knowledge, skill or time to develop a more thoughtful description or that they can’t pinpoint an underlying problem to be solved and that was a reason why the students were needed. It was interesting that some of the more thoughtful students noted that the client’s (and other stakeholders’) understanding evolved as the project progressed (J2.3). The other side of the coin in analyst-client relationship is that clients also come along with their own interpretation of the relationship which further confuses students. For example, some clients can feel intimidated by the presence of students whom they believe to be IS/IT experts and hence may be inhibited in explaining their situation and needs until they feel more confident and learn to trust the team members. Others may have expectations which are too high and assume too much from the team members both in terms of their skills and professional conduct which they are, of course, still developing.

Supervisors typically help to ameliorate the situation of inappropriate assumptions or expectations that students might have (or perhaps that they haven’t thought much about it) through discussions with students by trying to obtain a profile of the client from students (or other sources) and from there suggest how best to handle that particular client. Hence advice will be specific and targeted. The novice-expert literature doesn’t really address this issue except to suggest that expert analysts have “good” or exceptional” people skills but state this with little or no further qualification. One aspect of good people skills from observation of the expert analysts is that they try to understand their client and then adapt their approach to complement the capabilities of the client.

##### *7.3.2.1.2 Recommendation R18*

**R18 Supervisor meetings are needed to reinforce the ideas about the analyst role and help students through into its practical application in their project.**

Three problematic relationship models that students applied in this research have been suggested earlier i.e. the client as employer (A5); the teacher/assignment (A2); and student as the superior/IS expert (A37). If the relationship in capstone projects is reduced and represented very simply to interplay between three parties: client (representing also other organisational stakeholders), supervisor (representing also the academic requirements that need to be satisfied) and student (representing also the other team members) then the problematic relationships can be seen as to which party the student perceives to be dominant in this three way relationship. In the "client as employer" situation it is the client, in the "teacher/assignment" situation it is the supervisor and in "superior/IS expert" situation it is the student. For each of the problematic relationship models, possible consequences in behaviour or thinking are suggested.

In the "client as employer" model students see the client as "the boss" and not to be questioned. Consequently:

- Students accept what client asks for and do not probe to determine any potential underlying problem (A36)
- Students accept client's expectations regarding scope (and subsequent changes) and even approach to deliverable development (A37, A38, A40)
- Client is the primary judge of success (A28, A36)

In the "teacher/assignment" model students approach project as a project length based assignment. Consequently:

- Students expect the client and/or supervisor to provide clear goals and deliverables and are confused or annoyed with a "fuzzy" description of the project (A14, A15)
- Expectation that there is a known "correct" answer and prescriptive process to follow (A26)
- There is attention to meeting academic requirements and standards but lack of commitment to achieving a genuinely successful outcome for the client (A25, A28, A31)

In the "superior/IS expert" model students see themselves as the IS experts dealing with clients who don't really understand what they want

- Students interact with the client in so far as they can find an IS deliverable they want to deliver to the client (A10)

- Students are not  prepared to fully explain or discuss the other IT/IS options or possibilities and how these might better meet the client's needs or wants (A20, A21, A30)
- Students "go through the motions" of meeting the supervisor's requirements of researching, analysis and consultation (A28) but students are "locked in" to the originally determined deliverable.

The perceived relationship models adopted by students in capstone projects does not appear to have been the subject of focussed research in information systems, software engineering or other areas such as engineering or design. West (2011) briefly touches the relationship issue in the field of advertising but in this case from the client perspective. He describes clients as being "overinvolved" and trying to impose the role of "client as employer" or "underinvolved" in which they relinquish involvement and students may be forced to adopt the "superior/IS expert" relationship. In similar fashion one can view the situation of different supervisors creating having different perceptions of their relationship which have their own impact. A more focussed and detailed exploration of the assumed relationship models of the various participants and potential consequences as they interact and subsequent misunderstandings, conflicts and outcomes is beyond the scope of this research but clearly a potential area for further study.

If students have a basis for a relationship model aligned closer to that used by the experts in this research then this sets an appropriate mind set when they meet the client for the first time. Models for the consulting relationship have been suggested (Egan, 2013; Kakabadse, Louchart, & Kakabadse, 2006; Schein, 1990) which emphasise helping; trust and collaboration also appear to be relevant sources from which to draw ideas. Discussing these models can promote more confidence in students and give them "permission" to more critically question the client. At the same they need to listen to the client if they are genuinely out to understand and help the client throughout the project. For example, analysts must guide their clients through the project process (A24) although admittedly this is a process with which even the students are unlikely to be familiar. In the consultant model the client owns the problem (West, 2011) and determines if project ends successfully or not so it makes sense that students should support and guide their client so that their client understands their recommendations (or product). When the client needs to make decisions not only should those decisions be satisfactory (in the view of the client) but the client should feel informed as they make these decisions (A21).

While the early discussion on analyst-client roles can set the intellectual scene for students, it is not possible to provide a prescription that will handle every situation. As well, knowing how to apply the model in a real world situation is a skill that comes with practice. For example, one needs a certain confidence and calmness under pressure to be critical and questioning, or to defer difficult questions from a client or be able to refuse a client's request (A40). Expert P described the situation of one client who, in their first interview, "brow-beat" the team so that all team members felt very intimidated. Expert P first had to calm the team down, suggested that they had to maintain a professional approach (i.e. stay calm, objective and concentrate on their job) and after that the project went on to develop smoothly and the client turned out to be a relatively easy person with which to work. In another case, while students were well aware about the dangers of "scope creep", once they had their face-to-face meetings with their client some students were so eager to please their client that they agreed to client's every request without proper consideration of whether the requests were reasonable e.g. if it was within the team's skill set or if it could be accomplished in the project time frame. The "theory" flew out of the students' minds in the emotional engagement of face-to-face meetings. In that case of students who were too "eager to please" the supervisor had to step in, discuss the implications of their behaviour and try to get things back on track. This then became a useful lesson for the students.

### 7.3.2.2 Client Communication

#### *7.3.2.2.1 Recommendation R19*

**R19 Requiring teams to initiate and maintain regular client communications throughout the project should be mandatory and monitored by supervisors to ensure that it occurs; this communication might be to gather information, validate information, review findings, obtain opinions, indicate progress etc.**

Students value the direct client and stakeholder communication in their projects very highly because it makes the experience authentic (J3.11, J3.13, J3.14). However, after an initial burst of enthusiasm and communication, the expert supervisors found that there is a strong tendency by students thereafter to cut back on their communication with the client while they work on their solution (A31). This was seen as a serious problem by the expert supervisors who viewed client communication as something which should occur regularly throughout the life of the project if they wanted to ensure that they deliver something of value to the client. Strong interest in user involvement throughout the project by experts was described by Vitalari (1985) and by Schenk et al. (1998) and was consistent with the experts in this study. The diminished interest in client communication by novices noted by Schenk is also consistent with the students in this study. Wojahn et al. (2001) suggest that students must learn to appreciate that dealing with real world clients is not a straight line from problem to solution but often involves "surprises and setbacks" because clients can change their minds about their needs, clients are unclear about their desires or client's circumstances change.

Expert P observed that students often failed to take up the opportunities to validate their understanding of the project which benefits both the client and students. Regular and effective communication in the later stages of the project (e.g. such as when students discuss candidate solutions with client) can highlight lack of understanding or lead to changes in thinking (A30). Hirsch et al. (2001) suggest that the effort involved in effective communication with the client (and with their supervisor) sharpens ideas, uncovers flaws and brings to light new ideas and perspectives. Regular communication can engage the client through the team explaining the processes they are undertaking, informing him or her about their findings and discussing the different options with them is such a way that the client can make informed decisions. Both experts P and D espoused the idea very emphatically that when it came for students' final presentation or submission of the report to the client there should be no surprises in the content for the client; everything should have been discussed with the client beforehand. Finally, regular client communication also served social and political purposes for the analyst in that it reassures the client that progress is being made and that the client's input is valued (A30).

In spite of having the early discussion about having regular communications with their clients throughout the project some teams still fall away after the initial interviews. Lack of communication might be due to a variety of reasons. One reason might be habit; it is a carry-over from students' experiences with assignments in which they are typically handed out a clearly defined problem, expected to be worked on independently and then submit "the answer" on the required due date. Another reason suggested by Gupta and Wachter (1998) is that some students in their capstone projects had difficulty explaining their proposals to their clients and so we can imagine that some students, rather than persisting, might infer from this that their client had little to offer. Some students in the capstone projects described in Wojahn et al. (2001) became so engrossed in the technical issues of solving the problem that for them communication issues were the “last thing” they wanted to think about; the possibility that they might be solving the wrong problem was lost. Another possibility for lack of regular communication was Expert D’s observation that some novice analysts believed that they should not admit any lack of knowledge to the client; we can speculate that that these novices might want to avoid scrutiny. One should also not ignore that students have their work in other units of study competing for their time. Whatever the reason, the supervisor’s responsibility should be to monitor whether students are communicating regularly and effectively with their clients and, if not, determine the underlying reason. Apart from getting the project back on track, if brought to light it might reveal and resolve some important issue about the students that might enhance their development as analysts.

Regular weekly (or whatever period is deemed appropriate) reports by the team describing their communications with the client should be mandatory and checked by the supervisor to ensure that it is sufficiently detailed, appropriate and of a satisfactory standard for that stage of the project. A further idea drawn from the experience of Wojahn et al. (2001) in the running of their capstone projects is to ensure that a specific role is created within the project team to foster and maintain client communication. This firstly gives prominence to the idea that client communication is an important activity which some novices may not appreciate. Secondly, even in teams that see client communication as important, giving the responsibility to one individual increases the probability that it will be handled and handled well. Leaving it as a team responsibility can result in the classic case of “diffusion of responsibility” (Darley & Latane, 1968) in which a responsibility shared by everyone can result in it being ignored by everyone because each person assumes that “someone else” is dealing with it.

#### 7.3.2.3 Managing the client

A weak aspect of teams’ project management noted by the experts was with their management of their interaction with those others outside the team (A30). The common term used by all the experts was “managing the client” (A36) and sometimes more specifically “managing client expectations” (A38) because the client was the key stakeholder with whom there was greatest interaction but the concept extended to other stakeholders as well. Failure to manage user expectations is identified as a common risk across many projects (Petter, 2008). Managing the client goes beyond simply communicating with the client and deserves special treatment because it relates to a more pro-active aspect of the analyst role involving steering the client into particular directions which will support the activities that the analyst needs to perform and also to mediate the political and social aspects of the project. These are aspects of the support routines described in the ISAPS model described in Chapter 3.

Students have difficulty in managing their clients (A11). This is no surprise if this is the students' first project and so they are often unsure of what they are supposed to be doing (A9, A10). Examples already described include students who don't necessarily know what they should be achieving in interviews (J1.4) (A15) or those students who feel intimidated by the client or situation and so don't manage or negotiate circumstances into a satisfactory direction (A40) or students who fail to do the basic things that they should do (A16, A30). Managing the client is a more proactive process than simply communicating with the client and was an area of project management on which all the expert supervisors placed a great deal of emphasis.

*7.3.2.3.1 Recommendation R20*

**R20 Students should consider the client as part of the team.**

Expert G believed that students needed to develop a more client centric attitude to the project and argued that the client should be regarded as part of the team. He commented that the students tended to have their focus based around the team itself and the team's effort to solve the problem; the team viewed the client as clearly important but, in essence, an external party with which they needed to deal. Expert D also had an interesting observation that this tendency to separate the team and client is exacerbated by some clients who will deliberately attempt to "handover" the problem to the team and thus disengage themselves from the effort of having to be involved in the process of finding and developing solutions. The team is then be left to make assumptions about what the client's wants or needs so it should be no surprise that the client is left unsatisfied by what is provided. Expert D suggested that the problem is always owned by the client, remains the client's responsibility and that the team's presence is there to help the client to find a satisfactory solution to the client's problem (A30). The client centric attitude follows quite naturally if the analyst-client model is perceived as a partnership or collaboration which exists to solve the client's problem (A25) or the consultant model discussed by West (2011) rather than as a task assigned to the analyst (or student team) to go away and solve. Wojahn et al. (2001) also stress the value of direct client involvement with teams although they place the emphasis more on the client helping in the mentoring of students rather than students developing their client management and communication skills.

*7.3.2.3.2 Recommendation R21*

**R21 Students should not assume that the client has IS knowledge or skills.**

Clients should understand the conduct of their own business but should not be assumed be aware what is required by the IS analyst in order for the analyst to accomplish their task (A11). Hence there is a need for the analyst to manage the client so that they can acquire the information needed to achieve the project's final goal i.e. a satisfactory solution for the client (A30).

*7.3.2.3.3 Recommendation R22*

**R22 Supervisors must be prepared to provide guidance and support in managing clients.**

Several findings from analyst interviews relate directly to problems that students are likely to have with managing clients (A21, A30, A36, A37 and A38) and these are essentially due to students' inexperience. These findings apply to all clients however benign and cooperative they might be. However, some clients can be very difficult to manage and these are times when the supervisors' experience becomes particularly relevant and necessary. Lopez and Lee (2005) provide several examples of what they describe as "bad" clients. Some examples they give are clients who may want to be under involved or over involved (also (West, 2011)); clients who have "*wildly exaggerated ideas of what the students can accomplish*"; and clients who take on projects for the wrong reasons (i.e. ulterior motives). Fox (2002) also provided some categories of clients that students might find difficult to manage: the "talker" who likes to talk and frequently goes off topic, the "over accommodator" who provides little direction and is happy with whatever is provided, the "undecided argumentative" who represents a group of individuals who do not appear to be able to agree on anything and finally the "add-on" who is constantly adding new requirements. Difficult clients inevitably lead to a great deal of discussion between the students and their supervisor about how to best manage the client. This is a particularly important aspect of supervisor' support and in the situations where students cannot manage by themselves the supervisor may need to intervene directly with the client to protect the interests of the students and the project.

#### *7.3.2.3.4 Recommendation R23*

**R23 Students must seek to gain credibility with their client by operating professionally.**

One aspect of managing the client was gaining the trust of the client; however, this clearly goes much more than students simply trying to convince the client that they were friendly and well meaning. The expert supervisors describe the idea of establishing or developing credibility with the client. Students on capstone projects can potentially suffer from not being taken seriously by their client (A39) simply because the client knows they are students. Student need to convince the client that they do really know they are doing and hence establish their authority (Michell, Reast, & Lynch, 1998). Supervisors emphasised the necessity of being well prepared, doing the necessary research and also basics like being on time for interviews or presentations; following up on promises; dressing appropriately; keeping the client informed and involved; communicating clearly, effectively and with appropriate respect for the client and so on. These were often framed in the context of its impact on the client and whether it would support their credibility (A20, A23and A28) and therefore enhance their authority or standing. Initially students do not think in terms of developing credibility with their client or what that might entail (A20). Developing credibility isn’t simply about being knowledgeable and skilful. It means going beyond personal or team concerns with handling the project and requires being able to see things from the client’s perspective and bringing the client along with them on the project. However, some students didn’t naturally see the project in those terms (A29) and this potentially detracted from their relationship with the client. The idea of developing credibility did not appear so much in the early student journals but by the end of the project the term “credibility” and/or what it entailed appeared in the comments by many students so they had clearly absorbed the lesson from their supervisors (J3.3).

#### *7.3.2.3.5 Recommendation R24*

**R24 The concepts of managing the client and establishing credibility need to be discussed early in the project and maintained by supervisors throughout the project.**

This can be accomplished within a lecture or other suitable group based setting. Establishing credibility is something that students can work on immediately because they involve their own attitudes and behaviours within the project and the image they wish to project to the client. This also requires students trying to see the project from the client's perspective (A25) and adapting accordingly. Discussing the need to work collaboratively with the client (A24, A25) may help the students who "jump in" prematurely in finding a solution (A4, A5, A6) to see that solving the problem requires an ongoing dialogue with the client. Supervisors need to oversee that students aren't just communicating with their clients but also actively managing them (A36, A38) so that, for example, they don't meekly acquiesce to client requests (A1, A2) and actively keep the client involved in decision making (A21) on issues that will impact directly on the client and so on.

*7.3.2.3.6 Recommendation R25*

**R25 It is important that the team *as a whole* has the knowledge and skills and also balance of personalities that will allow them to achieve the project aims.**

Underlying the idea of managing the client is the need for students to be capable in the knowledge and skills areas such as Information Systems Development, IS Applications, Problem Solving and Critical Thinking and be prepared to develop new knowledge and skills relevant to the problem domain. However, it should also be kept in mind that a capstone project is a team enterprise and it is not necessary that each student individually has all the required knowledge and skills for the project. With respect to this, Expert G quoted the title of a book by Anthony Jay "*Nobody's perfect but a team can be*" (Jay, 1980). This suggests that the particular team membership is a significant determinant in a team's ability to develop credibility and for the success of the project (Agogino, Song, & Hey, 2007). Forming teams that are likely to perform well is not a trivial exercise (Deeter-Schmelz, Kennedy, & Ramsey, 2002). As well as knowledge and skills other factors to be considered are who selects the team (Chapman, Meuter, Toy, & Wright, 2006); differences in academic abilities of team members, personalities, students' enthusiasm for the particular project and so on (Aller, Lyth, & Mallak, 2008). Lack of literature on optimizing teams in capstone projects through a thoughtful and comprehensive selection process suggests an area for further study.

## 7.3.3 Team Management

### 7.3.3.1 Weak management techniques

From the observations of the supervisors, students don't students apply sophisticated project management techniques in their projects but they often don't even apply simple ones (A27). Students that had only experience of small scale group based assignments might find that strategies that worked in assignments might not scale up in capstone projects or find that it is not possible to work around or ignore problems as they had previously (A26). Some expected that their supervisor would take control and tell them what to do rather than they try to work it out themselves (J2.4). Some needed to be pushed to do long term planning spanning the entire project time frame and to review and update these plans regularly. More commonly students did take the initiative but there was a tendency to focus more on the short term activities that spanned over time frames of a week or so (J2.5) and not view these activities in the context of the overall project management in a disciplined and systematic way. Some symptoms observed in the lack of adequate project management techniques (or perhaps their ability to implement them) were:

- poor preparation e.g. for interviews with clients,
- poor control over distribution and coordination of work resulting work being submitted late or being of an inadequate standard (J3.5)
- poor distribution of work resulting in considerable extra work for some over others (J3.5)
- difficulties in dealing with some team members (J3.5)
- insufficient communication amongst team members or with the client (A31, J3.11, J3.14)
- some students not feeling that they able to adequately express their ideas (J2.8, J2.9)
- not appreciating the various types of contribution that different team members could make and therefore not using team members skills most effectively (J2.7)

Supervisors provided support by being able to confirm to the team when the strategies they were adopting appeared adequate which boosted the team's confidence, but when strategies weren't adequate they needed a wakeup call that they needed to do better (J2.10, J3.9). This reliance on supervisors' support was a strong theme across students but was much more pronounced in the undergraduate students than it was for the postgraduate students (J1.15).

##### *7.3.3.1.1 Recommendation R26*

**R26 There should be discussion early in the project dealing with project management; this discussion should be tailored to techniques and issues relevant to the type and scale of projects being conducted.**

The discussion should highlight that capstone projects require more management than students' prior experience with group assignment work but at the same time do not require the more comprehensive and formal processes and methods which would have been taught in prior Project Management courses which must consider "industrial strength" project management e.g. see (Topi, Valacich, Wright, Kaiser, Nunamaker Jr., et al., 2010). Students can be encouraged to discuss problems they encountered with teamwork in the past and which project management techniques that would be appropriate in capstone projects. Drawing from the experiences of previous capstone students may be particularly relevant to students beginning capstone projects (J1.9, J2.8, J2.9 and J3.14). Academic staff can set the minimum expectations for project management, e.g. development and maintenance of project plans, the need for regular team meetings with minutes and action plans, setting up a team information repository and so on. Several authors have emphasised the importance of project milestones as intermediate goals for teams to work toward (Delson, 2001; Feldgen & Clua, 2010; Geske, 2009; Katzenbach & Smith, 1993). However, in the spirit of students being encouraged to be proactive and to take control of their project while some of these goals might be imposed by academic requirements, the manner in which they are achieved should be left to each team to determine for itself. Certainly, suggestions and sample templates can be provided which provide guidance.

It was noted that most teams had not set any explicit agreements on standards of conduct or working arrangements at the beginning of the project and those teams that did not do so either believed that they had implicit agreements in place or thought that it would emerge naturally or did not consider the issue (J1.12). To avoid potential misunderstandings or problems, it might be explicitly required that teams set up agreements which outline standards of behaviour and expectations between team members (McKendall, 2000; Oakley, Felder, Brent, & Elhajj, 2004). While academic staff can provide guides as to the content for this agreement, its greatest value would appear to be in having students think about and discuss explicitly amongst themselves how they will behave and what they are prepared to do. It was also suggested that these agreements might be renegotiated later in the project if teams chose to do so.

##### *7.3.3.1.2 Recommendation R27*

**R27 Supervisors should actively monitor teams to detect areas in project management for improvement.**

Expert D observed that some teams can apply what appear to be good management practices, e.g. lots of meetings, discussion, good ideas and plans and so on which indicate lots of activity, but then they fail on the most important point which is that they do not produce tangible results e.g. documents, models, prototypes, recommendations et cetera (A28). In this case the supervisor's task is to try to analyse through discussion with the team why tangible results are not appearing (e.g. perhaps they are over analysing or their skills in a particular area are weak). The opposite situation could occur i.e. the teams producing tangible results, but discussion with their supervisor might uncover that their processes are poor which brings into question the value or quality of those results. Students may be are aware about project management in the abstract but judgment is required to apply it appropriately and effectively in a practical situation with real people.

The key issue in this recommendation is that a supervisor should not be passive and wait for teams to bring problems or issues to him or her. Taylor, Magleby, Todd, and Parkinson (2001), for example, suggest that active involvement by the supervisor is necessary to promote learning of teamwork skills. Students may not even be aware that they have management problems unless it is brought to their attention by their supervisor e.g. they are progressing too slowly (A28), or that they distribute and plan work inefficiently or that they are not proactive enough (A26) and so on. Hansen (2006) provides several examples ways in which a team might be dysfunctional e.g. poor communication, unclear goals, low morale, lack of trust and so on. These are management issues which team members might believe to be "normal" team behaviour or they may be aware that the team is not functioning very well but not be able to pinpoint the underlying problem. A supervisor who has experienced working with a variety of teams may well be able to determine the underlying problem(s) and potentially improve the project's progress and also provide a valuable learning experience (Agogino et al., 2007; Hansen, 2006; McKendall, 2000; Oakley et al., 2004; Zhou & Pazos, 2014). It is clear that students overwhelmingly appreciated the support of supervisors in keeping teams on track throughout the project (J1.15, J2.10) and that supervisors saw it as their responsibility to advise teams when they were significantly off track (A11, A26). In some cases, students are aware of a problem but ignoring it or unable to deal adequately with it. Examples of these types of problems are constant negative comments or other disruptive behaviours (McKendall, 2000)). In other cases they may work around the problem e.g. a team member is not doing their fair share of the work or the quality of their work is poor so other team members compensate by working harder. The expert supervisors actively monitored teams for these types of problems and addressed these issues as they were detected (A11, A26, J1.15, J2.10).

*7.3.3.1.3 Recommendation R28*

**R28 When supervisors determine an area for improvement in project management the supervisor should provide guidance according to the ability of students to appreciate and implement the improvement effectively.**

There were broad differences noted between the postgraduate and undergraduate students in the area of project management. Undergraduates described the importance of developing good communication and the need that this communication should be positive (J2.9, J3.14). This suggests that simply establishing the appropriate communication appeared to be an issue for them and the communication that did occur wasn't necessarily cooperative and supportive (J3.14). Postgraduates, on the other hand, were more concerned with working more effectively as a team through greater focus, better organisation, clearly defined roles and consideration of appropriate methodology (J2.9, J3.14). They appeared to have moved on from establishing and maintaining communication between team members in this aspect of project management and were looking for more advanced ideas.

When supervisors suggest improvements in project management these improvements have to take into account the capabilities of the particular students to implement that improvement. The concept of the "zone of proximal development" (L. S. Vygotsky, 1978; Wertsch, 1984) provides some insight with regard to the principle of how supervisors can deal with teams who appear to be at different stages of development. Vygotsky defined the zone of proximal development as "*the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers*" (L. S. Vygotsky, 1978, p. 86). The basic idea is that one needs to understand the underlying problem currently holding students back in terms of their project management, determine a more effective level of operation *which they are capable of understanding and implementing with supervisor support* and then and then guide them on to the new level. In the case of undergraduate students mentioned earlier this advice might be related to setting up appropriate communication channels, ensuring that they are disciplined in using them and encouraging them to be positive and supportive rather than negative and critical. On the other hand, describing to undergraduate students some technique for document collaboration could be beyond a team's ability to implement effectively if they don't yet communicate appropriately. In the case of postgraduate students the advice might be more focused on, for example, leadership style and appropriate teamwork models e.g. see (Biørnstad, 2007) for a review of models. *The supervisor can support the team as they explore and try out these ideas* on teamwork and leadership rather than stopping at providing relevant reading material.

#### 7.3.3.2 Team interaction

Most groups functioned well enough with supervisor support to be able to successfully complete the project with little conflict between the group members (A32). There was a reasonable spread of skills that students believed that they provided to their team e.g. attention to detail, leadership, team building and interpersonal skills and management and planning and creative thinking (J2.8). However, there were several types of problems that emerged. Leadership issues were probably the most common e.g. one leader who provided no direction when the team members were expecting direction or another who tended to micromanage which other team members resented (A33). Some team members were deemed by fellow team members to be unpleasant or difficult to work with (A34). Arguments about the fairness and contribution of work by each of the team members were not uncommon (A35). These were the problems that were raised with supervisors, usually in confidence, and standard practice would be that the supervisor would assist the students to deal with the problem themselves in the first instance and intervene directly only if that failed. It is reasonable to assume that only the more serious problems would have reached the attention of a supervisor. Providing students with a means to confidentially raise any issues as they emerge with supervisors before they become serious would be appear to be beneficial for a team.

##### *7.3.3.2.1 Recommendation R29*

**R29 Provide measurement tools such as peer evaluations and worklogs and apply them at strategic points in the project to provide different perspectives on individual student's contribution and performance.**

Examples of such measurement tools and their usefulness have been suggested in the literature (Basholli, Baxhaku, Dranidis, & Hatziapostolou, 2013; Farrell, Farrell, Kindler, Ravalli, & Hall, 2013; Farrell et al., 2012; Hansen, 2006; Vasilevskaya, Broman, & Sandahl, 2014). These can be used to monitor the work performed by each student and how well they are interacting within their team. Their presence alone is a motivation to all members of a team to improve their individual and/or combined performance. For supervisors they are a means of determining the work being performed and of becoming aware of problems as they emerge rather than have to wait for a student to raise an issue. Feedback can be provided to students to confirm those aspects which are working well and those that need improvement and this can lead to useful learning for students and a more effective outcome for the project (Farrell et al., 2012). These measurement tools can also be used as evidence to differentiate between students when final marks are being determined if this is required.

##### *7.3.3.2.2 Recommendation R30*

**R30 Teach and have students apply project management and team work knowledge and skills in a supervised fashion *prior* to when students become involved in capstone projects.**

The argument can be raised that students typically have had significant experience of team work in group assignments (as did all the students in this research) but simply putting students into groups and requiring them to work together does not automatically over time result in students who understand how to develop and work in high performing teams (Calhoun, 2014; Hansen, 2006; McKendall, 2000; Oakley et al., 2004). McKendall (2000) suggests that what typically happens in practice is that academic staff put students into teams and then "*spend no time at all in helping these students understand how a good team functions and how to manage the group problems that may arise*". Even in programs where team skills are taught very early in the program this alone was found to be ineffective unless it was also supported by structured feedback to the students; in the study described by Williams, Brian, Elger, and Schumacher (2007) this feedback was provided by peer reviews. Feedback can alternatively be provided by academic staff, however Dunne and Rawlins (2000) suggest that academic staff themselves may need training in how to develop and support high functioning student teams. The result of lack of teaching and supervised practice is that students learn about teams and team skills largely through trial and error which may lead to "workarounds" to problems rather than through a systematic and practical training and review process which develops high functioning teams.

This recommendation acknowledges that these skills are not developed quickly or easily nor are they intuitive. Furthermore, once students start the project their focus and effort goes toward solving the problem and there is little incentive for students to spend significant amounts of time learning about and investigating issues of leadership, management or team work unless, perhaps, they experience problems. Learning about and developing skills working in teams is a long term process which can begin in less complex situations such as group assignments earlier in students' courses. McKendall (2000) makes several suggestions toward improving teamwork which include conducting teamwork exercises that highlight potential problems or issues, development of team contracts which describe how teams will function, problem-solving exercises, as well as discussions about individual differences and how they affect team performance, group roles and leadership, communication patterns, cooperation and conflict, and encouraging the idea of teams supporting each other rather than being in competition. The more complex and stressful Capstone project environment appears to be a better place to refine management and team skills which have already been developed to a reasonable extent rather than to throw together students whose skills in these areas are still rudimentary.

## 7.4 Personal Attitudes and Capabilities

### 7.4.1 Introduction

This section highlights those aspects of personal attitudes and capabilities of students with which they appeared to have greatest difficulty when compared with the experts as they undertook their final year capstone projects. The key challenge areas identified were in dealing with uncertainty and complexity and being proactive.

### 7.4.2 Dealing with uncertainty and a complex project environment

Uncertainty and a complex project environment is created by difficulty in defining the problem, scope and goals, the range of different factors that need to be considered, that the solution may be very unclear and then further compounded by the social and political factors involved. This, however, is the normal situation and not the exception for real world projects (Geske, 2009). The aim should be to take the ill-defined situation and gradually transform into a well-defined project. Students vary in their response to this uncertainty. Observations from this research are that some students find the uncertainty energising and see the situation as an opportunity to explore, be innovative and provide a positive outcome for the client. Some, instead, find the uncertainty a cause for anxiety because there is no clear path to follow to some predetermined end point which lead to "*the right answer*" ("the blueprint" mentioned by expert P) hence they will fail in some way (A26). Some appear to find the uncertainty "annoying" if the uncertainty stems from the client or client's organisation (A14). The first of the responses is clearly in accord with the attributes of experts from the literature i.e. that they are motivated (Wynekoop & Walz, 2000), value autonomy and prefer challenging work (Smits et al., 1993).

Symptoms of students' uncertainty are that teams at various points can stall e.g. go around in circles unable to resolve an issue, waste excessive amounts of time on unproductive paths e.g. through excessive attention to detail (A26) or generate a great deal of apparent "busy-ness" but few tangible outcomes (A28). Of relevance from the literature is that some novices in design areas become so engrossed in the analysis that they subsequently fail to produce any significant outcomes (Cynthia J. Atman et al., 2007; C J Atman et al., 1999; Christiaans & Dorst, 1992; Kolodner & Wills, 1996).

#### 7.4.2.1 Recommendation R31

**R31 Students should be reassured at the beginning of their projects that in the real world situations are often uncertain and complex and this situation can be handled through being patient, persistent, disciplined and systematic.**

A student's confidence can be shaken if they go to their client with the unrealistic expectation that they will immediately understand the client's problem and foresee the one, "correct" solution. In the earlier chapter on IS expertise it was noted that even in laboratory style studies experts took more time to understand and analyse problems compared to novices, not less. Being aware that even experts in IS analysis with their greater knowledge and skill take considerable time to investigate and understand a problem is both sobering (because it indicates there might be a great deal of effort involved) but at the same time reassuring (because there's nothing "wrong" if the student also takes time). This same idea also applies to other aspects of the project such as researching solutions, working with the client, managing the team, creating and maintaining appropriate documentation and so on. What may have been adequate with earlier group assignments may not "scale up" within the more complex environment of the project. Experts are characterised by being patient, persistent, disciplined and systematic (Adelson & Soloway, 1985; Stolterman, 1992; Wynekoop & Walz, 2000) and this was supported by the advice provided by the expert supervisors (A13, A14). Again, if students are aware that expert analysts face exactly the same issues and that these issues have to be dealt with rather than avoided or ignored then students will be better prepared to handle any problems.

Essentially, this recommendation is about novices' mental preparation for the task ahead and removing false and potentially confidence sapping expectations. The Students could be better prepared for capstone projects by reviewing previously completed capstone projects and highlighting the problems, mistakes, dead-ends and the hard work encountered by others. One possibility is to invite students from previous capstone projects to discuss the difficulties encountered in their own projects. Prospective or beginning capstone project students are likely to identify with recent students of capstone projects and heed any lessons.

### 7.4.3 Becoming more proactive and self-reliant

It is clear that supervisors want students to be (or to become) proactive and self-reliant (A26). Being proactive and self-reliant in this context means students should initiate ideas and action to drive the project forward whenever possible. However, given students' lack of experience, this should be mediated by students confirming or discussing these ideas and actions with their supervisor, asking questions when in doubt and being prepared to listen and genuinely consider the advice provided. Being proactive appears to rely on the beliefs that: (1) one has the ability to contribute positively to the project (Pembridge, 2011, p. 85); (2) one has a significant degree of control as to what happens within a project; and (3) one accepts a significant degree of personal ownership and responsibility for the project outcome (Pembridge, 2011, p. 87). The first point is a matter of understanding the knowledge and skills that the student has acquired and having confidence in their abilities. Assuming that projects are selected appropriately in the first place and students assigned appropriately then the problem is really more about their personal confidence which some students lack (J1.7). Regarding the second point, the conduct of projects is such that students do have a great deal of autonomy but perhaps do not appreciate this particularly in the earlier stages of the project (A26). With regard to the last point, this is a matter of a student's apparent interest in the problem and desire to support the client; recall that in the Dreyfus model a critical aspect within the competency stage is that the novice takes responsibility for making and being accountable for decisions and actions. However, a student's motivation can be lacking if the student doesn't believe the project is authentic (J1.7), the client doesn't appear genuinely interested in the result (J1.7) or if the subject matter of the project doesn't interest them (J1.8). This can result in a half-hearted effort with a little concern over the project outcome for the client.

The role of the supervisor in helping students to becoming proactive and self-reliant can be quite important. Pembridge (2011), for example, states with regard to the psychosocial development of junior managers in engineering that supervisors in capstone projects can aid in the development of a student's self-efficacy and identity as a practicing engineer and that this "*provides junior managers the ability to take risks and think outside the box when approaching problems. In addition, it aids in the development of their own identity, allowing them to think and work independently.*"

#### 7.4.3.1 Recommendation R32

**R32 Students should be asked at the beginning of the project to review their own and other team members' areas of knowledge and skill and then match them to the requirements of the project to reassure them that they have (or can acquire) the appropriate knowledge and skills to successfully complete the project.**

This achieves two goals. Firstly, it reminds students of the knowledge and skills they have developed and hence give them confidence that they have the fundamentals (as a team if not individually) to cope with the project. Secondly, it gets them thinking about the project from a holistic perspective. If they find that they collectively don't have the required knowledge and skills to successfully complete the project then clearly it is a serious risk to the success of the project that needs to be addressed; strategies to address the situation might be to determine who in the team can acquire the required knowledge and skills, finding someone who the team can consult or in the worst case the team composition may need to be reassessed.

#### 7.4.3.2 Recommendation R33

**R33 To encourage a proactive approach from students, the role of the supervisor primarily to help them as a coach and mentor should be explained at the beginning of the project and then this idea reinforced by the supervisor.**

Students may misunderstand the role of the supervisor (e.g. that the supervisor is there to direct the team as expert D found with one team) and vice versa which can lead to frustration as one party or the other or both expect attitudes or behaviours that the other party is not providing. On the other hand, a supervisor needs to be alert to students who would prefer not to be proactive and self-reliant and who are very willing to allow the supervisor to "drift" into the role of de facto team leader (A26). If the supervisor directs the team this is very likely to result in a very “smooth ride” for all concerned so it is a temptation that needs to be resisted if students are to learn as much as they should from their project experience.

#### 7.4.3.3 Recommendation R34

**R34 Emphasize that while a major goal of the capstone project is to deliver real value to the client another major goal relates to the development of their expertise as IS analysts.**

The projects related to this research were all relevant to Information Systems and the projects have genuine clients with genuine problem. However, if some students are not motivated by the particular problem area or client they are dealing with, it could be pointed out that for their career development the particular problem or client is essentially a vehicle and that the most important goal from their participation in the capstone project is that they develop their expertise as IS analysts, namely, expertise in dealing with clients, project management and team work. This might motivate them more to absorb these important lessons rather than to focus on the particular project problem.

## 7.5 Critical Thinking

Critical thinking for students was found to be an area for improvement in terms of novice vs expert differences. This was an area identified which differentiated experts or exceptional analysts from other analysts (Stolterman, 1992; Wynekoop & Walz, 2000). Critical thinking is mentioned as an important skill to be developed within the Information Systems curriculum (Topi, Valacich, Wright, Kaiser, Nunamaker Jr., et al., 2010). It is not being suggested that the majority of students in this study had poor critical thinking skills but rather that in the more complex and uncertain context of real world projects these skills needed to be raised to a higher level. There are two areas of critical thinking identified as issues, namely application of existing knowledge and skills and developing credibility.

### 7.5.1 Application of existing knowledge and skills

Students sometimes struggled to apply their existing knowledge and skills to the problem domain (A17). In contrast, exceptional analysts are able to integrate knowledge areas (Curtis et al., 1988). Applying existing knowledge and skills into different settings is described in educational literature as "transfer of learning". People not connecting or applying the knowledge and skill they had learned earlier with the particular current situation is a widespread problem in education and training. e.g. (Doyle, McDonald, & Leberman, 2012; Grossman & Salas, 2011; Leberman, McDonald, & Doyle, 2006; Merriam & Leahy, 2005). Obvious reasons for this situation are forgetting what they had learned because considerable time had passed or an inability to see the connection between what they had learned and the current situation. In this study, an example of the former situation of forgetting what they had learned is the often unsophisticated initial approach to requirements analysis and description (e.g. see A10 to A17) when, in fact, requirements analysis was a prerequisite subject studied much earlier in their course. An example of the latter situation of the inability to see the connection was provided by expert G who supervised students who regularly used mobile phones with touchscreens but claimed they knew nothing about touchpads which users were using in the workplace (A17) i.e. the surface differences in appearance between the touchpad and mobile phone hid the underlying similarity of their operation. For the experts, theory and practice were intertwined (Kautz et al., 2004), however many students, at various times, lacked the insight into how to apply the theory to practice or to connect what they were seeing in practice back to the corresponding theory (Luntley, 2005). The experts, because of their thinking at high levels of abstraction, were able to effectively exploit analogy to compare events or situations for similarities or differences even though they might otherwise appear to others as completely unconnected (Dinesh Batra & Davis, 1992; I. L. Huang & Burns, 2000; Sutcliffe & Maiden, 1992; Vitalari & Dickson, 1983).

#### 7.5.1.1 Recommendation R35

**R35 As part of the project environment, key topics relevant to projects e.g. from requirements analysis or project management and so on can be presented or discussed to act as a quick review and/or reminder of topics which are relevant to the project(s).**

This might also be an opportunity to extend and/or focus material which might have been presented in a broad and general manner. If so, it should be presented or discussed in a way that is particularly relevant to the project(s) and therefore students are more likely to see a connection between the theory and its application. Supervisors in their one-on-one discussions with their teams can also explore with their teams any other existing knowledge and skills which might be peculiar to their particular project. It is clear that application of theory to practice is enhanced by several factors: the closer in time there is between the theory being presented and its application; the more relevant that the theory is to the particular situation; being reinforced by one-on-one coaching; the more motivated the student is to apply it; and self-efficacy (Grossman & Salas, 2011; Merriam & Leahy, 2005). All these factors can be exploited within the project environment in one way or another.

#### 7.5.1.2 Recommendation R36

**R36 In units of study prior to the capstone projects, application of existing knowledge and skills can be enhanced by applying theory to a variety of situations as close to real world practice as reasonably possible**.

This recommendation is made in contrast to the idea of teaching material as a set of facts and then examining it solely by tests and exams (Leberman et al., 2006; Merriam & Leahy, 2005).

### 7.5.2 Developing credibility

In terms of developing credibility (A20) expert D highlighted that students needed to work on their ability to substantiate in a transparent manner any recommendation to their client with evidence and clear logical argument not only that their advice was appropriate but also that they had researched and considered other possible options and were able to explain convincingly that their recommendation was superior to other possible options. This included drawing from recognised and reputable sources of knowledge where possible and using recognised and accepted processes and practices.

When supervisors were helping students with their final reports and presentations (A23) both of these tasks required the support of supervisors to improve the quality of students' work so that it was presented in a professional manner. This support could be advice on, for example, having a clear and concise description of the problem and requirements; the methodology or techniques used; the adequacy of the research conducted, the justification for the recommendation(s) or the structure of a report or presentation as a whole.

All teams, even those deemed to be the very best, needed help to some degree in being able to put together, in a convincing and well-structured manner, a detailed report spanning 30 to 40 pages (excluding appendices) or a 30 minute presentation which provided an understandable synopsis of the results of many weeks work to a fairly critical audience (A22, A23). Other indirect indicators of the need for improvement in critical thinking appeared in student journals where they would describe how well the team was going (J2.7, J3.15), how work was shared fairly and equally among the team (J2.6), and so on, but rarely was any evidence provided (anecdotal or otherwise) to substantiate these statements. Supervisors also commented on the fact that students often made assumptions (A6) which they then did not attempt to test (A7).

In summary, students needed to improve on their skills in presenting a long and complex argument, be more prepared to gather and present evidence to substantiate claims and have a greater awareness of the presence of assumptions and the need to detect and test them.

#### 7.5.2.1 Recommendation R37

**R37 Provide samples of previous or other relevant reports or presentations as a guide to what is expected.**

Those students who reviewed samples of previous work found them a helpful guide (J3.4, A22). Exemplars give students a very helpful idea of “quantity” as well as “quality” of work expected based on historical precedents (Gibbings & Snook, 2013). Given that every project represents a different client operating in a different context, even when the problem posed might be similar there is very little opportunity for students to plagiarise material since any material presented must be clearly relevant to the project and set in the context of the project. The fact that there is a team supervisor who has been working with them on a weekly basis and overseeing the steady development of their work and who will review their project report and presentation is a strong impediment to plagiarised or otherwise “regurgitated” material (A23). What was regarded as valid and a valuable learning experience was “copying” from previous reports in the broad sense of recognising interesting or useful approaches to presenting ideas or material, seeing resonant themes, observing how others have constructed and presented arguments, appreciating others’ attention to detail and so on.

#### 7.5.2.2 Recommendation R38

**R38 Throughout the project, supervisors should be aiming to enhance students critical thinking skills in their discussions with students and when reviewing any deliverables so as to raise students’ awareness of the need to be appropriately rigorous.**

In moving from the academic environment to the environment of a real world project, students may not know how to apply critical thinking appropriately in the more complex and "messy" real world projects. At one extreme they may be "over critical" and become so bogged down with detail and justification of the most minor points that they achieve little while at the other extreme they may be "under critical" and provide a result which appears to be no more than a "guess". It is clear that rigorous critical thinking was highly regarded by the experts (e.g. recall the issues and importance placed on developing credibility).

Supervisors should remind students of the need to be critical in their thinking and be prepared to criticise them when they don't apply it or if it is flawed. However, there is also the very real issue of limited time and resources in real world projects and an outcome has to be delivered. It is in this regard that supervisors, through their experience, can guide students as to how to "manage" their critical thinking skills to best effect in achieving a successful project outcome i.e. what should they concentrate on and how rigorous they need and can afford to be. This is an area where the experts' judgment gained from real world projects is an important factor in their effectiveness as supervisors (Taylor et al., 2001). Judgments made by IS experts will differ from those people with expertise in different areas of expertise such as teaching, research or technical areas but who don't have that relevant real world project experience to draw from.

#### 7.5.2.3 Recommendation R39

**R39 Earlier in the curriculum, provide realistic case studies for students to discuss and work on as means of developing critical thinking skills.**

Case studies are a useful way to introduce students to give students a glimpse into real world projects. Gupta and Wachter (1998) found that while students initially struggled with the complexities of realistic case studies they improved their critical thinking skills and improved also their ability to think holistically.

## 7.6 Communication Skills

### 7.6.1 Introduction

The need for regular on-going communication to take place among team members and stakeholders has been emphasised earlier. Communication skill relates to the quality of that communication. Exceptional communication skills were found to be a trait of exceptional IT professionals (Curtis et al., 1988; Khan & Kukalis, 1990). In the case of the capstone students these communications included interim problem descriptions, scope statements, statements of requirements, memos and so on and not just the final report or formal presentations. The expert supervisors found that there were areas for improvement in the quality of the communication from students to their client.

## 7.6.2 Quality of communication

It is expected that any information communicated is appropriate and correct (inasmuch as it is known to be correct at the time the communication is made), conveyed in an appropriately professional manner and understood by the person(s) receiving it (Hirsch & McKenna, 2008).

The experts commented that students needed to be guided in terms of the clarity and precision of their language. Firstly, students needed to take more care with their use of language which could at times be somewhat careless or imprecise. Illustrative examples were promising to “implement” a solution when in fact they were only developing a proof of concept prototype or that a requirement that a product should be “user-friendly” without any indication as for whom it would be user-friendly or how “user friendliness” would be determined (A18). Secondly, some students’ communications to their client were very casual and while some clients didn’t mind this others found it unprofessional. Thirdly, it is apparent that information that is communicated but not understood by the intended audience is not of much value; some students did not seem to appreciate this and might, for example, present technical information to a quickly bewildered client (or supervisor for that matter). Supervisors expressed particular concern with communications relating to project scope, requirements and deliverables since they set the expectations of the client as to what would be provided and in a real world project was likely to form the basis of a contract.

### 7.6.2.1 Recommendation R40

**R40 Encourage students to appreciate the value of well-considered and effective communications during the course of the project as a means of improving their own understanding and avoiding confusion and misunderstanding with other stakeholders.**

Wojahn et al. (2001) suggest that the effort of trying to communicate clearly and effectively forces the communicator to clarify their own thoughts so that it brings to light their own misunderstandings, confusions or gaps in knowledge. The tendency, particularly those who are more technically oriented, to concentrate on finding a solution to the detriment of effective communication risks the often quoted “right solution to the wrong problem” as well as creating disgruntled stakeholders with whom they are supposed to be collaborating. Some element of review and feedback of students’ communications to their clients by supervisors is worthwhile from a learning perspective as well as reducing potential problems later in the project.

### 7.6.3 Formal reports and presentations

At the end of the project, virtually all students found the writing of their final report for the client and the final oral presentation challenging (J3.4) and acknowledged and appreciated the feedback provided by supervisors (J3.7). In the area of engineering design, Wojahn et al. (2001) found that while engineering students were very competent with their technical designs there was a broad disappointment in the quality of the presentations and especially the reports from faculty members, some clients and even some students. From the perspective of this research, it was clear that allowing students to submit draft reports for comment and to perform a practice presentation to the supervisor significantly improved the quality of both the report and presentation (A23). It was mentioned earlier that from a critical thinking perspective supervisors helped students with issues related to logical structure, providing evidence, describing methodology, logical argument and so on (J3.6).

From the communication perspective supervisors stressed simplicity, clarity and audience consideration (A22, A23, J3.3). Material presented to the client should demonstrate appreciation of the client’s interests and perspective i.e. it should be relevant to them and understandable by them; students sometimes wanted to include aspects of the project that were really of concern only to the students themselves, e.g. difficulties with their teamwork, their risk management strategy or how they communicated among themselves.

Supervisors also commented on presentation style with the aim of trying to achieve a professional standard. In the case of the report, apart from presentation style and formatting, advice might cover, for example, judicious use of tables and graphs to help the reader or using appendices appropriately. In the case of an oral presentation it might cover how students present themselves and ways of making the presentation interesting as well as informative.

#### 7.6.3.1 Recommendation R41

**R41 Supervisors should review and provide feedback on formal client reports and presentations before they are seen by the client so that students have an opportunity to learn from that feedback and improve the quality of that report or presentation.**

Students may not have much in the way of appropriate models to draw from when they set about preparing their reports or presentations and supervisors can help fill that gap. Supervisor can highlight significant areas for improvement. From an educational perspective this provides a useful learning experience. The value of review and feedback of intermediate products e.g. problem definition, scope statements, designs delivered during the project to the client is supported by Geske (2009) who suggests that it is the key to a successful project. Wojahn et al. (2001) also stress the importance of high quality final reports and presentations for capstone engineering students; while these students are technically capable in terms of developing high quality ideas or products for their client, their final report or presentation may fail to demonstrate convincingly the quality of that idea or product. Students can learn from their supervisors about how to go about developing a convincing report or presentation (A22, A23). Additionally, it can be argued that the review and feedback process is closer to the professional environment in which reports are typically reviewed and improved by peers and senior personnel, perhaps several times, before they are sent to the client and similarly key presentations would be checked and rehearsed. From a practical perspective, if capstone projects involve real clients then there would appear to be some obligation that the deliverables to the client are of a satisfactory, if not necessarily a fully professional standard. From a practical perspective, it should also be kept in mind that having a track record of delivering value to clients can make sourcing future projects considerably easier.

## 7.7 Supervisors and supervision

### 7.7.1 Introduction

Students appreciated the feedback and guidance that supervisors provided. In the areas relating to understanding the problem and finding solutions students stated that supervisors helped by clarifying and developing ideas and asking probing questions (1.15). In the area of project management, students appreciated supervisors' guidance that focused the team's efforts and kept the project on track (2.10, 3.11). Further, the students clearly took in the emphases supervisors placed on: planning and coordination; team members should be supportive of each other; and the need for frequent, effective communication amongst team members and with clients.

Taylor et al. (2001) studied capstone project teams involved in engineering design for real world clients and suggested that "*the coaching role is essential to the success of the capstone educational experience*". They found that there were four key indicators of successful design teams derived from statistically significant quantitative survey data and each with a positive correlation with success. Two of these related directly to the coach (equivalent to the supervisor in this thesis), namely, their "*awareness and concern of team success*" and their "*ability to assist in both team and design processes*". They also provided three further findings which they suggest indicated the need for an effective supervisor: a unified vision between the team members and the coach, the ability of the team to involve all members in the team and that an external reviewer cannot effectively substitute for a coach. These findings are consistent with what has been observed in this research with regards to the expert supervisors and the role they played.

The key challenges for supervisors found here relate to understanding and effectively implementing their role as a supervisor and the assessment of teams and students.

### 7.7.2 Understanding and working effectively in the role of the supervisor

It was clear that the way that supervisors interacted with teams varied from team to team and adapted as a team progressed through the project depending on the needs of the team. This personalised approach is supported by others e.g. Taylor et al. (2001). Expert P, for example, had a one relatively proactive and independent team whose ideas he found needed to be challenged (in this case acting as the Devil's Advocate) while another team needed help and advice and to be pushed along to some extent. An issue for supervisors with industry experience but little experience with students is that they are used to working with other experienced professionals who should need relatively little support. These colleagues might interpret a supervisor's close involvement in their work as interference or "micromanagement". In contrast, an academic environment typically deals with novices and is about learning so close involvement is necessary. Expert D described that his approach to the supervisor role changed with increasing experience and that he became more effective when he became more proactive and more engaged with the team so that he could become better aware of their progress and their thinking. Others have also reported on the importance of engagement and awareness with capstone project teams e.g. effective mid-term evaluations of projects is positively correlated to final team performance (Agogino et al., 2007; Lau, Beckman, & Agogino, 2012). Fox (2002) described one capstone project team who didn't want to "bother" their supervisor, tried to resolve difficult technical issues on their own and subsequently struggled to complete their project. The message is that supervisors need to learn about the capabilities of their capstone students and be prepared to be far more involved and supportive of them than they would be of professional colleagues. Ideally, all supervisors should have experience in real world projects. In practice, however this may not always be possible and in such situations these inexperienced supervisors need to be willing and be provided with the opportunity to engage with industry experienced supervisors to obtain advice in dealing with real world clients and problems.

#### 7.7.2.1 Recommendation R42

**R42 Explain and discuss the supervision process with supervisors at the beginning of the projects to ensure they understand the various roles they can potentially play with their students during the course of the projects and the responsibilities they have to their teams.**

This recommendation is the counterpart to the recommendation that the supervision process and role of the supervisor explained to students at the start of the project. Supervisors may interpret their roles somewhat unilaterally and simplistically e.g. to "take charge". However, Taylor et al. (2001) suggests that "*Research … shows that team independence leads to increased responsibility of team members for the project outcomes, which in turn results in better performing teams.*" This aspect is consistent with the competency stage of the Dreyfus model of skill development (S. E. Dreyfus, 2004; S. E. Dreyfus & Dreyfus, 1980) which suggests that at this level the learner needs to become emotionally engaged with the task and feel responsible for its outcome. This would suggest that supervisors should step back when it came to decision makings so that students felt in control and therefore responsible for any consequences of their decisions.

On the other hand, Taylor et al. (2001) suggest that supervisors need to be there and to be "*aware and helpful*". As has been mentioned earlier students appreciate supervisor guidance (J1.15, J2.10) and supervisors were often more aware than students when the students needed support because experts could foresee less productive directions or outcomes that students could not foresee (A11, A26). If the supervisor is to be effective with regard to students' learning then being there means that they need to ask questions and expect thoughtful responses; they need to ask for and expect to see tangible outcomes of progress. A passive approach of waiting for students to ask for help may miss many opportunities for learning and when support is provided it may be much later than is ideal or beneficial for the project. If supervision is regarded purely as a passive advisory role then one may as well eliminate the supervisor and provide students with something like a project help desk instead.

One should also not forget that there is also a responsibility to the client in a real world project. No conscientious project manager would simply sit idly by on a project that he or she was managing, especially if a team looked like they were floundering or heading in a wrong direction, and watch the project fail when it was this possible to save it. Similarly, there is a responsibility on the part of the supervisor from a project outcome perspective to make themselves aware of the status of all aspects of the project that are relevant to its progress, provide advice when they feel it is needed and, overall, exert enough influence on the direction of the project needed to bring about a successful outcome. This is consistent with the other role suggested by Taylor et al. (2001) that should be "*guiding the team in both team processes and the design process*".

From all the earlier discussion it should be clear the supervisors' involvement needs to be multifaceted and adapt to the students and the situation: sometimes being passive, sometimes taking charge, sometimes critical, sometimes encouraging and so on but always with a view to developing students' skills as IS analysts.

#### 7.7.2.2 Recommendation R43

**R43 Supervisors should be proactive and review all significant items of work produced by their teams as well as encouraging discussion about project management, teamwork and personal attitudes and productivity so as to be able to provide constructive and immediate feedback as necessary.**

This recommendation is deliberately qualified by the words “as necessary” because it is also clear that teams need to feel in control if they are to develop independence and a sense of responsibility for their project (Pembridge, 2011; Taylor et al., 2001; Zhou & Pazos, 2014). Supervisors should therefore be cautious when providing advice that they do not inadvertently “take over”. Advice, for example, can often be couched in the form of questions or ideas for exploration rather than presented as directives. Supervisors should also be willing to trust their teams to try out their ideas and support the team in their execution even if the ideas don’t necessarily seem promising at the time. If the ideas work out then well and good but if they don’t work out then supervisors should not be judgmental.

Formative assessment in which supervisors provide feedback on student’s behaviour and the artefacts that they produce is particularly useful in capstone projects. Because the feedback from supervisors is immediate and can be incorporated as they work on their project it is likely that students will be highly motivated to pay attention to that feedback, act on it and learn from it (Chiaburu & Lindsay, 2008; Grossman & Salas, 2011). This can be contrasted with students’ previous experiences of the learning process in which the learning lesson (e.g. a lecture) is separated from its practice (an assignment) and formative feedback is limited or occurs as a part of summative assessment when there is far less motivation pay attention to the feedback and learn from it (Grossman & Salas, 2011; Merriam & Leahy, 2005).

It is clear from the analyst interviews that supervisors provided support and guidance from the very beginning of the project starting with the project brief through to helping them with the final report and presentation; this support covered analysis and design, project management and even personal attitudes and productivity. It was also clear that students appreciated the feedback from their supervisors in these many aspects of the project and appeared to gain a great deal from it (J1.15, J2.10, J3.3, J3.4, J3.7).

If the supervisor doesn’t actively take the trouble to look at the work produced by the team or to find out how they are operating then that limits the extent of learning that can take place. Adopting the more passive role of adviser relying on students to bring up issues can mean that the team can be adopting poor practices or approaches the effects of which may not be noticed until significantly further along in the project at which point the damage may be done and it may be difficult or not possible to overcome. As expert D mentioned in this regard, simply asking how things were going might simply elicit the response, "We're going okay" which students might believe to be true but is not actually the case or they might be deliberately covering up some problem or deficiency. Examples might be poor analysis, lack of communication with the client, poor teamwork or leadership, an unprofessional attitude when dealing with the client and so on. While students are encouraged to take the initiative with regard to the project, at the same time the supervisor must oversee that it is being conducted appropriately and at an appropriate standard. If the aim of the capstone projects is the development of students' expertise as IS analysts then this development will be severely limited if the supervisor does not proactively seek to engage with students to determine what they are producing, how they are behaving and how they are thinking.

#### 7.7.2.3 Recommendation R44

**R44 Provide opportunities for supervisors to obtain feedback on their supervision and to discuss ways to improve their effectiveness as supervisors.**

Taylor et al. (2001) suggests that supervisors "*desire and need feedback on their coaching performance during the experience in order to more effectively coach their team*". Anecdotally, if the opportunity to meet other supervisors presented itself, it was found that supervisors needed little, if any, prompting to engage in informal discussions to share their experiences and help each other if there was a problem or opportunity for improvement. For example, in one such informal discussion both experts D and P who were more experienced in supervising teams described how they were "caught out" by teams by teams that appeared to be progressing satisfactorily but, in fact, were not. They independently suggested that in future they would be more diligent in expecting to see tangible outcomes of progress and not rely so heavily on student statements suggesting satisfactory progress. If these informal discussions are taking place and working well then that may be sufficient.

It could be decided that regular meetings are needed to bring supervisors together. For example, within the context of the way in which capstone projects are conducted within this capstone project environment, timing meetings shortly after students have submitted their peer reviews and work logs (around 4 weeks apart with the projects in

this research) is auspicious since these often uncover problems that need to be addressed; for new supervisors this can be the time to explain to them about the peer reviews and work logs and how to interpret and deal with them.
These discussions can also be regarded as the cognitive apprenticeship model in action with supervisors explicitly describing and discussing their understanding and issues and thereby learning from each other.

### 7.7.3 Summative assessment of student work

Assessing project work is difficult (Gibbings & Snook, 2013; McKenzie, Trevisan, Davis, & Beyerlein, 2004). Each project is different and presents unique challenges; some projects are clearly defined with clients that know what they want and easily available while other projects can be poorly defined, change midstream or have clients that are difficult to work with. From a holistic perspective the assessment should cover technical quality of the products produced, the robustness of the activities undertaken from problem definition to product delivery, people management and team work and professional behaviours demonstrated (Beyerlein, Davis, Trevisan, Thompson, & Harrison, 2006; Keefe, Glancey, & Cloud, 2007; Maleki, 2009).
In evaluating project work, the experts understood what was required from a professional standpoint but at times they expressed some difficulty understanding how to assess work from an academic standpoint (S1). Expert G also brought up the issue of the inherent bias in assessing a document or presentation that he himself had helped students put together.

#### 7.7.3.1 Recommendation R45

**R45 For assessing project work the suggestions are**

1. **Develop grading rubrics comprehensive enough for the wide range of expected projects and general enough to take into account the particular circumstances of each project**
2. **Develop and make available a bank of previously assessed work that includes marks and comments that can act as precedents database for assessing new work.**
3. **Major items of summative assessment should be assessed by at least two people; one assessor should include the team supervisor and one or more independent assessors familiar with assessing capstone projects.**

4. **Include client satisfaction with the product produced and quality of their interaction with the team as factors in assessment**

Some form of grading rubrics are obviously needed for formally assessed items but in a situation where no two projects are the same these rubrics must be general enough that they can be applied to cater for virtually any situation. However, when pitched at a high level of abstraction it might be difficult to interpret and apply in a precise and consistent manner across projects. The second point addresses the problem introduced by the first point, that is, It also helps to reduce bias if one provides exemplars to work from which can be used as a basis for comparison. A bank of previously assessed work with marks and associated marking commentary demonstrates how others have interpreted the rubrics and provide some reasoning as to how those marks were arrived at. A sufficiently large bank may also include examples of one or more projects similar to the one being assessed which can provide more direct comparisons and help the assessor to arrive at a mark consistent with previous assessments. In assessing capstone projects it is important to strive for a grading that is carried out in a "*consistent, repeatable, and reliable manner*" (Gibbings & Snook, 2013) and the combination of a well thought out rubric and a bank of previously assessed work can help to provide that.

The third point highlights two needs. The first need is that major items of summative assessment should have some independent scrutiny of the work being assessed which may provide different and unbiased perspectives on the work being assessed. However, an independent assessor may have no understanding of the particular circumstances of the project and may arrive at a mark or grade which does not take those circumstances into account. One such example is that of a client that has had a poor understanding of their needs and as a result the client and team have spent considerable time in re-defining the problem and scope, points which the independent assessor(s) may not appreciate. Therefore the second need is to have the direct supervisor as part of the assessment team to provide the opportunity to explain any particular project circumstances.

The fourth point addresses the issue that the purpose of the project is to work with the client to produce something of value to the client. The client's viewpoint should be taken into consideration in the assessment of students' work because the client can provide their perception of the value of the deliverable produced for them which might otherwise be missed and it provides the client's perception of the quality of their interaction with the students (Keefe et al., 2007). To not do so is potentially to have only the students' version of the relevance and value of their work and client interaction. From personal experience, these assessments should be relatively quick and easy to complete (otherwise they are forgotten about or the client labours excessively over them) and should provide easy to understand (and relatively concrete) descriptions of the aspects for client comment. The assessment team (i.e. supervisors) should then use this as they see fit to mediate students' assessment.

## 7.8 Overview of recommendations

As particular issues were highlighted in this chapter, recommendations were also made as to how these issues might be addressed. In some cases the recommendations reflect how particular issues were dealt with within the project environment while other recommendations are suggestions as to how an issue could be avoided or dealt with in the future. In total there are 45 recommendations made. Table 2 summarises the different issues and the corresponding recommendations. The reader will note that sometimes there are multiple issues addressed by a particular recommendation and at other times there are multiple recommendations addressing a particular issue.

The recommendations intended to be implemented at the beginning of or early stages in a capstone project are R1, R2, R3, R4, R5, R6, R17, R21, R24, R25, R26, R31, R32, R33, R34 and for supervisors R42.

The following recommendations relate to setting up resources to be available for reference to students or supervisors: R29, R37, R45.1 and R45.2

These recommendations relate to preparing students earlier in the degree program before they begin their capstone project: R7, R15, R16, R30, R36, R39.

Those recommendations specifically related to supervisors are R42 and R44.

## Table 2 Issues and Recommendations

| Issue | Recommendation |
|---|---|
| Students place too much reliance on the client's project brief. | R1 When students are provided their project briefs they need to be made aware that the client's description of the problem will require further clarification and analysis and not accepted on face value. |
| Students do not feel concerned about the success or failure of their project. | R2 At the beginning of the project students need to be made aware that the responsibility for the success of the project lies largely with them and not with the client or their supervisor. |
| Students may deal with their client using a relatively inappropriate mental model of the relationship. | R3 Before meeting clients, discuss the client-analyst relationship with students and suggest appropriate models for working with the client. |
| Students underestimate their own knowledge and skills and overestimate those of their client.<br><br>Students poorly utilize their prior experience, knowledge and skills.<br><br>Students have an unquestioning acceptance of client's project description. | R4 Encourage teams to make explicit the knowledge and skills of each team member and how the skills may be utilised on the project. |
| Students don't do adequate background research for client meetings.<br><br>Students do not have a sophisticated strategy for developing and asking questions for problem understanding and requirements gathering. | R5 In preparation for client meetings, students should be encouraged and expected to do relevant background research. |
| Students do not have a sophisticated strategy for developing and asking questions for problem understanding and requirements gathering.<br><br>The team has a premature solution focus.<br><br>Students have an unquestioning acceptance of client's project description. | R6 Students need discussion about and support with adopting a strategic and holistic approach to gathering information, in particular how to develop and structure their questions for their early interviews with clients, and means by which they can validate their findings. |
| Students demonstrate poor questioning strategies for problem understanding and requirements gathering.<br><br>Teams have a premature solution focus.<br><br>Students have an unquestioning acceptance of client's project description. | R7 Prior to beginning the capstone project, provide students in earlier units of study with opportunities to define, scope, deliver and assess their own projects. |

| | |
|---|---|
| Students demonstrate poor questioning strategies for problem understanding and requirements gathering.<br><br>The team has a premature solution focus.<br><br>Students have an unquestioning acceptance of client's project description.<br><br>The team does not adequately confirm and validate their findings after interviews. | R8 Supervisors should discuss the interview process used by the team and review their subsequent analysis and findings of interviews with a view to discovering and highlighting any ambiguities and areas to follow up. |
| Students poorly utilize their prior experience, knowledge and skills. | R9 Supervisors should encourage students to think about their prior experiences beyond their knowledge and skills acquired in academic studies and how these might apply in their project. |
| Students demonstrates inadequate thinking at different levels of abstraction<br><br>Students do not think in a sufficiently holistic manner. | R10 Encourage students to make use of conceptual modelling and simulation and to demonstrate thinking from a high level design perspective. |
| The team's research or information gathering is insufficiently comprehensive or detailed.<br><br>Teams have untested assumptions.<br><br>Teams place overreliance on the client to provide the project requirements. | R11 Students should use relevant checklists and other such aides which are available to explicitly demonstrate that they have been comprehensive and thorough in the research and information gathering. |
| Teams demonstrate a passive approach to requirements gathering.<br><br>Teams place overreliance on the client to provide the project requirements.<br><br>The team's requirements gathering is insufficiently comprehensive or detailed.<br><br>Teams lack creativity or initiative in their requirements gathering or researching of potential solutions. | R12 Students should demonstrate that they have explored a wide variety of relevant requirements gathering techniques e.g. interviewing a variety of different stakeholder groups, applying standard requirement checklists, questionnaires, viewing relevant industry publications, visiting similar organisations, reverse engineering potential software solutions to determine requirements etc. |
| Teams demonstrate a passive approach to requirements gathering.<br><br>Teams place overreliance on client to provide the project requirements.<br><br>Teams lack creativity or initiative in their requirements gathering or researching of potential solutions. | R13 Students should regard an aspect of their role as analysts is to bring ideas to their client that they may have not previously considered or not fully appreciated. |
| Teams do not demonstrate sufficient progress.<br><br>Teams pursue unproductive or inappropriate avenues in the project for lengths of time that seriously threaten timely project completion. | R14 Supervisors need to actively monitor their teams so that they are aware of their progress and then help them to get back on track if they are becoming significantly unproductive or stalling in some way. |

| | |
|---|---|
| Students have inadequate understanding of holistic and design based problem solving approach.<br><br>Teams have a premature solution focus.<br><br>The team demonstrates slow or no progress toward possible solutions. | R15 Within prior units of study use realistic or real world case studies to demonstrate the issues involved in a holistic and design based problem solving approach. |
| Students have fragmentary knowledge or skills in IS analysis which do not incorporate adequate holistic and design based approaches for solving realistic problems. | R16 Develop and incorporate a unit on advanced analysis and design for the IS area for those wanting to specialize in IS analysis. |
| The client-analyst relationship model held by students at the beginning the project may not be appropriate for an effective project outcome or further development towards becoming professional IS analysts. | R17 The analyst role should be discussed with students before meeting their client so as to prepare them for their first meeting. |
| The current client-analyst relationship model demonstrated by the team members is not appropriate for an effective project outcome or for further development towards becoming professional IS analysts. | R18 Supervisor meetings are needed to reinforce the ideas about the analyst role and help students through into its practical application in their project. |
| The team demonstrates lack of communication with client to the extent that it may lead to an ineffective solution to the client's problem or disaffected client.<br><br>The team members neglect the broader interpersonal, social and political aspects of the project which need to be managed for progress towards becoming professional IS analysts. | R19 Requiring teams to initiate and maintain regular communications throughout the project should be mandatory and monitored by supervisors to ensure that it occurs; this communication might be to gather information, validate information, review findings, obtain opinions, indicate progress etc. |
| The team has an inwardly directed focus which tends to treat the client and other stakeholders as external to the overall development effort. | R20 Students should consider the client as part of the team. |
| Students overestimate the clients understanding or abilities needed to develop an effective IS based solution. | R21 Students should not assume that the client has IS knowledge or skills. |
| Students have difficulties is managing and supporting clients and other stakeholders | R22 Supervisors must be prepared to provide guidance and support in managing clients. |
| The client does not trust the team's ability to develop an effective solution.<br><br>The team interacts with the client in a manner which the client regards as unprofessional or reduces their credibility that the team can offer an effective solution. | R23 Students must seek to gain credibility with their client by operating professionally. |

| | |
|---|---|
| The team lacks understanding about how to manage clients and to build trust and credibility.<br><br>The team operates in a manner which the client regards as unprofessional or reduces the credibility to the client that the team can offer an effective solution. | R24 The concepts of managing the client and establishing credibility need to be discussed early in the project and maintained by supervisors throughout the project. |
| The team appears unable to work together effectively or lacks the combination of knowledge and skills required to provide an effective solution for the client. | R25 It is important that the team as a whole has the knowledge and skills and also balance of personalities that will allow them to achieve the project aims. |
| There is little consideration of project management techniques most appropriate to the scale and complexity of the project. | R26 There should be discussion early in the project dealing with project management; this discussion should be tailored to techniques and issues relevant to the type and scale of projects being conducted. |
| Potential improvements in project management are not considered or discussed with the team. | R27 Supervisors should actively monitor teams to detect areas in project management for improvement. |
| Suggested improvements by the supervisor about the team's project management techniques are not applied, poorly applied or ineffective. | R28 When supervisors determine an area for improvement in project management the supervisor should provide guidance according to the ability of students to appreciate and implement the improvement effectively. |
| There is a lack of explicit recording and evaluation as the project progresses about the individual contribution of each team member to the team and project outcomes. | R29 Provide measurement tools such as peer evaluations and worklogs and apply them at strategic points in the project to provide different perspectives on individual student's contribution and performance. |
| Teams are dysfunctional or never develop into effective high functioning teams. | R30 Teach and have students apply project management and team work knowledge and skills in a supervised fashion prior to when students become involved in capstone projects. |
| Anxiety or frustration by students because they lack a clear understanding the client's problem early in the project.<br><br>Students overestimate their clients knowledge, understanding or abilities needed to develop an effective IS based solution. | R31 Students should be reassured at the beginning of their projects that in the real world situations are often uncertain and complex and this situation can be handled through being patient, persistent, disciplined and systematic. |
| Underestimation by team members of their teams understanding and abilities to develop an effective IS based solution.<br><br>Team members lack confidence, independence or self-reliance. | R32 Students should be asked at the beginning of the project to review their own and other team members' areas of knowledge and skill and then match them to the requirements of the project to reassure them that they have (or can acquire) the appropriate knowledge and skills to successfully complete the project. |
| Students have a passive approach to the project or expectations that the supervisor should drive the project. | R33 To encourage a proactive approach from students, the role of the supervisor primarily to help them as a coach and mentor should be explained at the beginning of the project and then this idea reinforced by the supervisor. |

| | |
|---|---|
| There is lack of interest by a student to the particular project assigned. | R34 Emphasize that while a major goal of the capstone project is to deliver real value to the client another major goal relates to the development of their expertise as IS analysts. |
| Student's prior academic knowledge and skills are not effectively applied to the project. | R35 As part of the project environment, key topics relevant to projects e.g. from requirements analysis or project management and so on can be presented or discussed to act as a quick review and/or reminder of topics which are relevant to the project(s). |
| Student's prior academic knowledge and skills are not effectively applied to the project. | R36 In units of study prior to the capstone projects, application of existing knowledge and skills can be enhanced by applying theory to a variety of situations as close to real world practice as reasonably possible. |
| Students lack understanding of the standards of various deliverables expected. | R37 Provide samples of previous or other relevant reports or presentations as a guide to what is expected. |
| Critical thinking demonstrated by students is not pitched at an appropriate level of rigor. | R38 Throughout the project, supervisors should be aiming to enhance students critical thinking skills in their discussions with students and when reviewing any deliverables so as to raise students' awareness of the need to be appropriately rigorous. |
| Critical thinking demonstrated by students is not pitched at an appropriate level of rigor. | R39 Earlier in the curriculum, provide realistic case studies for students to discuss and work on as means of developing critical thinking skills. |
| The benefits of clear and effective communication with clients and other stakeholders are not appreciated by students. | R40 Encourage students to appreciate the value of well-considered and effective communications during the course of the project as a means of improving their own understanding and avoiding confusion and misunderstanding with other stakeholders. |
| The quality of presentations or reports by students is relatively poor or fails to reflect the technical quality of the solution provided to the client. | R41 Supervisors should review and provide feedback on formal client reports and presentations before they are seen by the client so that students have an opportunity to learn from that feedback and improve the quality of that report or presentation. |
| Supervisors are unsure of or have significantly misinterpreted the expected approach to supervision. | R42 Explain and discuss the supervision process with supervisors at the beginning of the projects to ensure they understand the various roles they can potentially play with their students during the course of the projects and the responsibilities they have to their teams. |
| Supervisors do not adequately review the work produced by teams or monitor their project management and teamwork. | R43 Supervisors should be proactive and review all significant items of work produced by their teams as well as encouraging discussion about project management, teamwork and personal attitudes and productivity so as to be able to provide constructive and immediate feedback as necessary. |

| | |
|---|---|
| Supervisors are unsure how effective they are in their role as supervisors and how they could improve. | R44 Provide opportunities for supervisors to obtain feedback on their supervision and to discuss ways to improve their effectiveness as supervisors. |
| Supervisors are unsure how to apply assessment criteria and standards.<br><br>Supervisors may find it difficult avoid bias in their assessments because of their closeness to their teams.<br><br>The quality of the team's interaction with the client and value of the product to the client are not considered within a team's overall assessment. | R45 For assessing project work the suggestions are<br>1. Develop grading rubrics comprehensive enough for the wide range of expected projects and general enough to take into account the particular circumstances of each project<br>2. Develop and make available a bank of previously assessed work that includes marks and comments that can act as precedents database for assessing new work.<br>3. Major items of summative assessment should be assessed by at least two people; one assessor should include the team supervisor and one or more independent assessors familiar with assessing capstone projects.<br>4. Include client satisfaction with the product produced and quality of their interaction with the team as factors in assessment |

## 7.9 Review of the Competency Stage of the Dreyfus model

### 7.9.1 Introduction

In Chapter 3 the competency stage of the 5 stage model for developing expertise was described and expanded upon to focus it onto the development of IS expertise in IS analysis. This description made use of literature on novice-expert differences on the topic. Here the Competency stage of the five stages is revisited and the findings from this research are summarised with the points relevant to learners in the competency stage of IS analysis. The reader is reminded that this description of the competency stage is written in the context of students who are in the final stage of an information systems degree program or something similar. These findings might not be very applicable to someone entering in the IS analysis area who has a significantly different background. An example of a significantly different background would be someone who has qualifications in a business area and several years of business experience working with others in business; such an individual may well bypass many of the client related issues mentioned in this chapter. Within the description reference is made to recommendations that are relevant to a particular issue that is mentioned.

### 7.9.2 Revised Competency stage

This level begins when the individual begins working in the role of an IS analyst in a real world situation with real clients with genuine needs. The difficulty for those entering this stage is how to go about the problem solving process in real world projects (Armarego, 2002; Connolly & Begg, 2006; DeGrace & Stahl, 1990; Fitzgerald, 1998; I.-L. Huang, 2009; I. L. Huang & Burns, 2000; Kleeman, 2005; Schenk et al., 1998; Stolterman, 1992).

Even if the learner works within a smaller organisation, in this stage the learner begins to appreciate the complexity of the organisation and the interconnectedness of people, processes, management, and technology and so on. *"With more experience, the number of potentially relevant elements and procedures that the learner is able to recognize and follow becomes overwhelming.*" (S. E. Dreyfus, 2004) In real world situations, the complexity of and subtle differences between situations is such that it is not possible to prepare the learner for all the eventualities, precisely what to look for and what actions to take.

Students learn that while their clients may have a good understanding of their own business, they cannot assume that the same clients understand how to go about solving a business problem from an information systems perspective (R1, R17, R21). They need to become aware of the knowledge, skills and experience that they have developed and then, by comparison, what their clients may lack (R4, R32).

In order to be become more effective as IS analysts, students need to abandon less effective relationship models with which they may be more familiar (e.g. teacher – student, employer – employee, parent – child) and develop more effective ones (e.g. consultant – client) (R3). These latter models are both more collaborative in nature and allow them to challenge, question, and advise their clients so that they can apply their knowledge and skills to satisfactorily determine and later to solve the client's problem (R18).

Students need to learn to become proactive and take responsibility for driving the project forward to a satisfactory outcome rather than expect others (e.g. the client, stakeholders or supervisors) to do so (R8, R33). The student has to accept significant responsibility for the outcome of their work. If they make mistakes, do inadequate analysis, make or accept unwarranted assumptions, if they don't fully understanding the procedures, rules or requirements (R2) then the success of any project is jeopardised. While they may be unsure about the consequences of decisions made or actions taken, they must still be prepared to make those decisions or take those actions and review the consequences in order to learn from them (R34).

They may have difficulty recalling relevant knowledge, skills and experiences they have acquired or seeing their application to the various aspects of project work (R9, R35, R36) so they must consciously review what they know to see if there is any relevance and application to existing situations. In this stage they learn to associate the abstract concepts in methodologies, techniques and models with what they perceive in the real world and how to apply the methodologies, techniques and models from a practical perspective (R10). It is in this stage that the learner develops knowledge and skills on the smaller scale (e.g. interviewing, requirements elicitation, various modelling techniques etc.) but they still haven't developed extensive holistic knowledge (R6, R10, R16).

Their tendency to not adequately test assumptions (Schenk et al., 1998) or confirm requirements (R12) leads to errors. Because of their comparatively sparse knowledge structures and limited experience (Atwood et al., 1979; D. Batra & Davis, 1989; Sutcliffe & Maiden, 1992), students need to consciously seek out standard techniques, models, prepared checklists and other aids related to IS analysis which are available and appropriate to their project and then apply them as best they can so as to avoid making basic errors or omissions in their work (R11, R12).

Students learn that they cannot rely solely on standard solutions to standard problems and must be prepared to initiate and follow through on their own research into the problem domain and into potential solutions to find effective solutions (R5, R11, R12). They gradually develop the confidence to be creative and innovative and in doing so bring ideas to the client for consideration that they themselves or the client may not have previously considered (R12, R13).

Students start to appreciate how much a group of individuals can achieve if they are able to communicate, cooperate and support each other effectively (R25, R29, R30). Instead of the client being considered as an external party who provides a problem and requires a solution they learn to see the client as central to the success of the project and someone with whom they must collaborate closely if they are to provide effective solutions (R18, R19, R20). They realise that clients need to managed, supported and guided through all stages of a project (R22) and that they must operate in a professional manner which gains the client's trust and confidence (R23, R24, R41). Students begin to develop and impose on themselves rigorous professional standards regarding the quality of the work they perform even when the client and others would not necessarily become fully aware of the underlying quality of that work performed (R37, R38, R39, R40). The student's developing professionalism to their work means that their intrinsic interest in the project problem or client does not affect the professionalism with which they undertake any project (R34).

The strategic planning they perform is conscious, deliberate, analytical and abstract. They can appreciate the interconnectedness of things from a logical and analytical perspective but situations are not perceived in a holistic and design focussed manner (R15, R16). Their goal generation is relatively poor (Schenk et al., 1998) and they have difficulty associating their abstract long range plan with practical concrete implementation and vice versa (R14, R15, R26). With increasing experience they are better able to allocate more realistic time frames to particular tasks or activities which, particularly in the early parts of this stage, are often widely off the mark. "*At this point, because a sense of what is important in any particular situation is missing, performance becomes nerve-wracking and exhausting, and the student might well wonder how anybody ever masters the skill.*" (S. E. Dreyfus, 2004) Their inexperience does not allow them to necessarily perceive the most critical and important issues involved in a project that they need to concentrate on (R14) combined with an approach to discovery and testing of assumptions which may not be adequate (Sutcliffe & Maiden, 1992) means that the project appears relatively complex to them. They easily go off track on their project and sometimes don't realise it or, if they do realise it, sometimes don't know how to bring the project back on track (R14, R27, R28).

Within this stage, the learners' fragmented knowledge means that they miss features in trying to understand a problem (Schenk et al., 1998). They tend to approach problems from the bottom up rather than top down (Mackay & Elam, 1992, p. 151) and tend to focus on surface characteristics (Sutcliffe & Maiden, 1992). Students have difficulty understanding and determining the business problem and eventually transforming it into a well-defined project with objectives that can be realistically achieved using information systems methods and solutions (R7, R8, R31). While they consider a variety of problem solving strategies these strategies tend to be relatively general in nature and less effective compared to those applied by those who have higher levels of expertise (Schenk et al., 1998). Students have difficulty applying a design based perspective which appropriately balances researching the problem and problem scope holistically with searching for satisfactory solutions (R6, R7). Their lack of experience in problem solving and the design process may cause them to become stuck in analysis or to decide on a solution prematurely (R15).

What sets up the learner for movement into the next stage is the positive and negative experiences from this stage which "*strengthen successful perspectives and inhibit unsuccessful ones, and the performer's theory of the skill, as represented by rules and principles, will gradually be replaced by situational discriminations.*" (S. E. Dreyfus, 2004)

## 7.10 Chapter Summary

This chapter gathered together and synthesized the findings of the literature on novice-expert differences, the interviews with expert supervisors and analysis of students' journals. The results were grouped within the relevant areas of IS analysis knowledge and skills in which the various issues occurred: Problem Solving, ISD Process Knowledge, Personal Attitudes and Abilities, Critical Thinking and Communication. Recommendations were made to address issues with students' competency based on a review of literature from a variety of fields dealing with student projects, suggestions by the expert supervisors, colleagues involved in capstone projects and this researchers own experience. A summary of the recommendations was provided together with a table (Table 2 Issues and Recommendations) which cross linked all the significant issues with recommendations for addressing any issue. The chapter concludes with a reviewed and expanded version of the Competency stage of the Dreyfus model of expertise development for IS analysis based on the findings of this research.

The next chapter is the concluding chapter which summarises the finding of this thesis and demonstrates that the original research questions have been answered.  It suggests that that the findings are trustworthy and that they are transferable to capstone project students in the IS discipline and may also be of value to those involved in conducting capstone projects in other fields as well.

# 8 CONCLUSION

## 8.1 Introduction

This chapter reviews what was learned from this study and its recommendations. The research limitations are described. The contribution that this work provides to researchers, educators and practitioners is presented then followed by suggestions for further research.

## 8.2 Findings and contributions

The research question posed at the beginning of this thesis was: *How can the professional judgment of final year Information Systems students be improved to better deal with Information Systems analysis and design projects that involve real world problems and clients?*

The research question was broken down into three sub-questions. The first two were:

> *What aspects of professional judgment in ISAD do final year Information Systems students demonstrate difficulty or gaps in their knowledge and skills when dealing with Information Systems analysis and design projects based on students' reports and the observations of their expert supervisors?*
>
> *How do the difficulties or gaps in knowledge and skills of students determined as a result of this research compare with the literature on novice-expert differences in ISAD and educational literature on students studying ISAD?*

This section discusses the findings and conclusions from addressing the first two sub-questions.

The investigation began by exploring the literature regarding the concept of professional judgment which established the idea that trying to apply the theoretical knowledge and universal principles was inadequate in handling real world problems. In order to do so one needed to develop expertise in that domain and in this case Information Systems Analysis and Design (ISAD).

### 8.2.1 Knowledge, skills and activities in IS analysis and design

To establish the knowledge and skills required in ISAD a review of the literature examining the more recent recruitment surveys in the IS and IT area was conducted to determine the categories of knowledge and skill thought relevant by employers wishing to employ ISAD analysts. This review provided a taxonomy of knowledge and skills, namely, critical thinking skills, interpersonal skills, communication skills, ISD process knowledge and skills, IS applications knowledge and skills, technical knowledge, personal attitudes and abilities, problem solving skills, organisational knowledge, business knowledge and problem domain knowledge. There were distinctive areas of knowledge, skill or activities suggested by Iivari et al. (2004)which differentiated ISAD analysts from other analysts operating in the same space, these were the knowledge of typical IT applications and how they can be used effectively in organisations, the alignment of IT artefacts taking into account its holistic context, development of user requirements, organisational implementation and change management related to the implementation of IT within organisations and the evaluation of IT within its organisational context. Seven core activities of ISAD analyst were also suggested, namely, business problem analysis, business modelling, IS strategy evaluation, requirements elicitation, mediation, solution design and change management.

### 8.2.2 Novice-expert differences in ISAD

A literature review of novice-expert differences in ISAD and related fields was conducted and the findings summarised by aligning them to each of the categories suggested in the taxonomy of knowledge and skills found earlier. Many of the results of this study regarding the differences between final year capstone project student and experts in ISAD were consistent with previous literature. For example, it was found that students did have difficulty dealing with complexity and uncertainty; some did not easily see the relevance of the previous knowledge and skills they had acquired; many were not holistic enough in trying to understand the problem domain and many did not appreciate the potential negative impacts of undetected or untested assumptions. However the learning environment provided to students with lectures, other support material and supervision by the experienced supervisors assisted students through their projects.

Other findings of the study did highlight areas of difference little mentioned in the novice –expert and other literature related to ISAD. One area could be described as the legacy of years of academic work responding to academic assessments. This has led to particular ways of thinking that have been appropriate and successful as students but now have to “unlearned”. One of these is the tendency to view projects as extended assignments in which they expected the project to be clearly defined and with it a reluctance to question the problem description, underlying assumptions and goals. Many students were clumsy in their approach to questioning clients and other stakeholders in determining the project problem, scope and requirements. They did not necessarily appreciate that this process can take significant time. Often they did not put enough effort into, or perhaps were unaware of the need for, validating their understanding particularly with the client. Students were often not proactive enough in driving their project forward. Experts in this study took much more effort over these matters.

### 8.2.3 Analyst - client relationship

A key area of difference between novices and experts related to the relationship between the client and analyst. As might be expected, many students were clumsy in dealing with the client particularly in the early stages. Usually they were too subservient, tended to overestimate the client’s knowledge and skill with regard to the information technology aspects of the project and tended to underestimate the information and support they needed to provide their client at all stages in the project. Students tended to be inwardly focussed and inclined to present the “final” solution to the client. In contrast, the experts tended to see the client as a partner and central to the project and hence had great emphasis on keeping the client abreast of developments and involved in any relevant decisions. Experts demonstrated emotional engagement and professional satisfaction by trying to provide something of genuine value to the client. Their approach was not simply to give the client what they had asked for but to enter a genuine dialogue about the client's needs. Overall, this suggested that students did not have the same type of client-analyst relationship mental model as the experts.

### 8.2.4 Project management

The experts noted that students did not demonstrate use of sophisticated project management techniques. However, this didn't appear as a significant issue. Possibly the scale and type of these projects may not warrant sophisticated project management techniques. Another possibility may have been that supervisors and the created educational environment (e.g. through lectures, assessment requirements) provided sufficient cues as to what needed to be done at various times in the project. When teams did encounter difficulties, the lessons they learned tended to be quite fundamental but it appeared that they had a real impact. Some of these lessons were the importance of communication amongst the participants of the project, being proactive, managing complexity and team work. Virtually all students expressed their appreciation of their supervisor in guiding them through the process and what they had learned from their experience.

### 8.2.5 Problem solving strategies

Students did not demonstrate any comprehensive problem solving strategy and goal setting. This was consistent with the literature. One lesson that students did learn was the importance of understanding the client's problem as soon as possible. This is clearly had a real impact because several students stated that they would give this advice to new project students.

There were two important ideas that emerged from an examination of the literature regarding the activities of ISAD analysts and the novice-expert differences in ISAD. The first was the chaotic nature of the problem-solving process in practice compared to that commonly espoused. This led to the IS Analysis Problem Solving (ISAPS) Model proposed in Chapter 3 based on the strategic decision making model of Mintzberg (Mintzberg et al., 1976). The second was design research which suggests that experts in design areas make early solution conjectures, use these to explore the problem further and as a result problems and solutions evolve as more is learned about both. Informal observation of the experts in this study was consistent with the early solution conjecture idea. The ISAPS model accommodates this approach.

### 8.2.6 Five stage model of skill acquisition for ISAD

At the end of Chapter 3, using the novice-expert differences found in the literature it was possible to populate and specialise the Dreyfus Five Stage Model of Skill Acquisition (S. E. Dreyfus, 2004; S. E. Dreyfus & Dreyfus, 1980) to suggest one possible path to development for ISAD skill development. This path begins with the student beginning their course of tertiary study through to expert level. Using the research findings, at the end of Chapter 7 it was possible to provide a considerably more detailed description of the competency stage of the model which corresponds to the level in which ISAD capstone projects students were believed to operate.

## 8.3 Recommendations to enhance students professional judgment

The third sub-question was

> *What recommendations can be made which could enhance Information Systems students' professional judgment and development in ISAD?*

Answering this sub-question required a synthesis of the work and findings developed from the previous sub-questions together with ideas from the literature published by other researchers involved in project work from a variety of fields, from informal discussions with the supervisors and from the experience of this researcher. The 45 recommendations made in Chapter 7 are indicative that there are many and various ways to further develop student's expertise. Some of these can be implemented before students undertake capstone projects while others are meant to be implemented during the course of the capstone project. Many of these recommendations were focussed directly on developing students' knowledge and skills. With respect to the client-analyst relationship it was suggested that students should be exposed to the concept of ISAD analysts using a consultant model as a basis. Models which represent analysts as purely requirements gatherers or solution developers largely ignore the client relationship and completely miss the proactive, supportive and helping role that the experts thought that professionals should perform if they are to be truly effective.

It is suggested that ISAD should be presented to students with the broader design perspective and something like the ISAPS model. If students were more attuned to these concepts, they would be better prepared to deal with the idea that problems, requirements and solutions evolve. They would subsequently be more willing to adopt a more consultative approach with their clients. As potential solutions are explored and problems and goals reframed, creativity and innovation become normal aspects of the project process.

Some recommendations were directed at improving supervisors' ability to supervise and the supervision process. Experienced supervisors are a vital element in developing students for professional practice but the supervisors themselves believed that they were also learning to be more effective supervisors as they developed their experience in supervision. It seems obvious that one should also put effort into developing supervisors' knowledge and skills as supervisors and working on improving the supervision process. This should subsequently further facilitate the development of expertise in students.

## 8.4 Dependability of the research

With regard to dependability, the students in this study are a sampling of the types of students involved in our IS capstone projects but they were not intended to be a statistically representative sample. Also, the experience of the participating supervisors working with students was over several semesters and not just a single semester, so the supervisors' observations go beyond a single cohort of students. The results therefore should be viewed as adding to understanding and providing guidance rather than trying to be predictive.

## 8.5 Transferability of the findings and conclusions

The detailed description of the educational environment and process used in this study should allow others to judge the extent to which the results of the research might be transferable to existing or new contexts. It is relatively common for courses to have Capstone projects which involve real world clients with real problems in some form and students with little, if any, professional experience. It is expected, therefore, that the results of this study will resonate with many others even across fields beyond Information Systems.

Could other teachers expect to be able to reproduce this experience for students? There was no extra funding provided specifically for the running of these capstone projects e.g. extra resources or extra funding to hire the expert supervisors. These are run routinely every semester in the manner described in this thesis. Students write journals every semester so the journals to which students responded were not an added burden because of this research. Having four expert supervisors at one time was a bonus but our experience shows that if you advertise appropriately (e.g. to former students, alumni or organisations already having links to your institution) there are many professional analysts with varying levels of experience willing to share their knowledge with students. Working in conjunction with professional analysts can be a very worthwhile experience for academic staff to develop their own abilities in the management and conduct of ISAD projects.

## 8.6 Research limitations

There were several limitations identified:

- Having expert supervisors guide students during their projects can be regarded as a confounding factor in determining novice-expert differences i.e. this study was not pure observation of student behaviour. While supervisors were able to gain a deep understanding of their students their presence may also have biased results.
- The responses and analysis of students' journals was based around one cohort of students and a relatively small number of supervisors. Further research with other cohorts of IS students and other expert supervisors may potentially yield further information.
- All students were required to respond with regard to journals and all agreed to provide their journals for this study so there was no sampling bias introduced through some students volunteering for the study and others not. However, while students were encouraged to be open and honest in their responses, their responses may have been inhibited knowing that they were to be viewed by supervisors. Furthermore, some students were more diligent than others in responding to the journals; the argument could be put that the responses and results of the analysis are therefore biased toward the more diligent and reflective students.
- The analysis of the student and supervisor data was performed entirely by this researcher. This ensured consistency in approach across all aspects the data. This work was reviewed by research supervisors, is largely consistent with the novice-expert literature and the reported results appear to be well accepted by colleagues. However, Constructivist philosophy suggests that each person's perspective, including this researcher, is inherently biased and this is acknowledged.

## 8.7 Contributions to research and practice

This research provides several contributions to research and practice in teaching Information Systems Analysis and Design:

- For those who conduct ISAD capstone projects, it provides insights into the difficulties that students may encounter and their reactions to different situations as they engage with real clients and problems in capstone information systems analysis and design projects. It also suggests improvements to the educational environment during ISAD capstone projects to provide more effective development and support for students.
- For IS educators, it provides further understanding of how to improve the teaching of ISAD knowledge and skills prior to beginning capstone projects so that students can be more effective while conducting their capstone projects.
- For educators who conduct capstone projects in other fields which involve real world clients and solving real problems as an important aspect of their work (e.g. requirements engineering, software engineering, business analysis and even other areas such as engineering and architecture amongst others), they may find some useful ideas and recommendations.
- For those who employ, manage, supervisor or mentor new graduates who are to be involved ISAD in a professional capacity, the issues experienced by these students are likely to be similar to the ones described in this research. Therefore this understanding should also suggest the types of difficulties that ISAD analysts in the early stages of their professional careers will experience and areas on which to focus to improve their professional judgment.
- For the IS/IT related professions and for researchers in ISAD, it adds to the knowledge regarding the development of expertise in Information Systems Analysis and Design. There have been many publications across the Information Systems and other related fields in terms of differences between experts and novices in practice and these have not been classified as “educational” and much of this work sits quite comfortably in amongst this literature.

## 8.8 Future research

There were many recommendations made regarding better preparation of students for their capstone projects either earlier in their course or during the conduct of the project.

It would be worthwhile following through with these recommendations and to evaluate their effectiveness.

There have been suggestions regarding the idea of ISAD incorporating design. Something in the nature of a phenomenographic study regarding conceptions of design among ISAD students and professional analysts might provide valuable insights into how the design conceptions evolve and then use that knowledge to further develop design thinking. Similar studies could be conducted into the client-analyst relationship, teamwork and other areas. All of these could be valuable in enhancing the development of expertise.

This particular study was focussed around final year undergraduate and postgraduate students. A similar study could be conducted with graduates recently hired into analyst positions with a view to determining the areas for improvement. Comparing the final year students with the recently hired graduates might elicit a different set of areas for improvement because of the different context in which recently hired graduates operate. It might also provide further insight how students could be better prepared for work as analysts.

Another area of research could relate to supervisors and the supervision process. How can supervisors be better prepared to deal with students and the supervision process? Can the supervision process be refined and improved by suggesting ways to detect problems? How can discussions be conducted so that they better bring out the ideas and thinking? Once potential issues and problems have been detected what suggestions can be provided to effectively deal with them?

Finding sufficient suitable professional analysts to act as supervisors for all teams is probably not feasible in many cases. One avenue is to appoint academic staff with limited professional experience as supervisors. There are a number of questions that could be addressed. Are there minimum levels of particular knowledge, skill or experience that are essential? What is the appropriate training or induction required? Is there need to provide support from expert analysts and, if so, what would be the best manner to provide this support? Are there academic staff who have more aptitude for becoming effective supervisors and, if so, how can they be identified?

## 8.9 Summary

With the approach taken within this study, the research framework that was developed, the results determined and recommendations developed it is believed that the original question posed:

*How can the professional judgment of final year Information Systems students be improved to better deal with Information Systems analysis and design projects that involve real world problems and clients?*

has been appropriately addressed and answered though a credible, confirmable and dependable process.

A clear understanding of what was meant by professional judgment and expertise in ISAD was established and justified why professional judgment needs to be developed through direct experience. The range of knowledge and skills required by ISAD analysts was established. It was proposed that there is a distinctive set of activities, knowledge and skills involved in ISAD analysis that differentiated ISAD experts from other professionals operating in the same space. This suggests how ISAD can uniquely contribute to people and organisations and guides the ongoing development of ISAD expertise.

This work has provided a clear and detailed understanding of the differences between final year capstone students and experts in ISAD and subsequently the areas that that most needed to be improved. The many recommendations made for improving students' expertise describe how students expertise can be improved. This should be a useful guide to others involved in preparing students for professional practice in ISAD but may also be of benefit in other related fields. The comprehensive description of the learning environment and capstone project process should help those who may wish to translate this work across to their own circumstances.

# 9 REFERENCES

Ackoff, R. L. (1979). The Future of Operational Research is Past. *The Journal of the Operational Research Society, 30*(2), 93-104.
Adelson, B., & Soloway, E. (1985). The Role of Domain Expenence in Software Design. *Software Engineering, IEEE Transactions, SE:11*(11), 1351 - 1360.
Afflerbach, P., & Johnston, P. (1984). On the use of verbal reports in reading research. *Journal of Reading behavior*.
Agarwal, R., & Tanniru, M. R. (1990). Knowledge acquisition using structured interviewing: an empirical investigation. *J. Manage. Inf. Syst., 7*(1), 123-140.
Agogino, A., Song, S., & Hey, J. (2007). Triangulation of indicators of successful student design teams. *International Journal of Engineering Education, 22*(3), 617.
Agrawal, D., Candan, K. S., & Li, W.-S. (2011). *New Frontiers in Information and Software as Services: Service and Application Design Challenges in the Cloud* (Vol. 74): Springer.
Alexander, P. A. (1992). Domain knowledge: Evolving themes and emerging concerns. *Educational Psychologist, 27*.
Aller, B. M., Lyth, D. M., & Mallak, L. A. (2008). Capstone Project Team Formation: Mingling Increases Performance and Motivation. *Decision Sciences Journal of Innovative Education, 6*(2), 503-507. doi: 10.1111/j.1540-4609.2008.00190.x
Allwood, C. M. (1986). Novices on the computer: a review of the literature. *International Journal of Man-Machine Studies, 25*(6), 633-658.
Anderson, R. C. (1977). The notion of schemata and the educational enterprise. In R. C. Anderson, R. J. Spiro & W. E. Montague (Eds.), *Schooling and the acquisition of knowledge* (pp. 415-431). Hillsdale, New Jersey: Erlbaum.
Anderson, R. C. (1978). Schema-Directed Processes in Language Comprehension. In A. M. Lesgold, J. W. Pellegrino, S. D. Fokkema & R. Glaser (Eds.), *Cognitive Psychology and Instruction*. New York:: Plenum.
Anderson, R. C., & Pearson, P. D. (1984). A Schema-Theoretic View of Basic Processes in Reading Comprehension. In D. P. Pearson (Ed.), *Handbook of Reading Research*. New York: Longman.

Aragón, G., Escalona, M.-J., Lang, M., & Hilera, J. R. (2013). AN ANALYSIS OF MODEL-DRIVEN WEB ENGINEERING METHODOLOGIES. *International Journal of Innovative Computing, Information and Control ICIC International, 9*(1), 413-436.

Argyris, C. (1976). *Increasing Leadership Effectiveness*. New York: Wiley.

Argyris, C. (1977). Double loop learning in organizations. *Harvard Business Review, 55*(5), 115-125.

Argyris, C., Putnam, R., & Smith, D. M. (1985). *Action Science: Concepts, Methods and Skills for Research and Intervention*. San Francisco, CA: Jossey-Bass.

Armarego, J. (2002). *Advanced Software Design: a Case in Problem-based Learning.* Paper presented at the 15th Conference on Software Engineering Education and Training (CSEET02).

Atman, C. J., Adams, R. S., Cardella, M. E., Turns, J., Mosborg, S., & Saleem, J. (2007). Engineering Design Processes: A Comparison of Students and Expert Practitioners. *Journal of Engineering Education, 96*(4), 359-379. doi: 10.1002/j.2168-9830.2007.tb00945.x

Atman, C. J., Cardella, M. E., Turns, J., & Adams, R. (2005). Comparing freshman and senior engineering design processes: an in-depth follow-up study. *Design Studies, 26*(4), 325-357. doi: http://dx.doi.org/10.1016/j.destud.2004.09.005

Atman, C. J., Chimka, J., & M, B. K. (1999). A Comparison of Freshman and Senior Engineering Design Processes. *Design*
*Studies, 20*, 131-152.

Atwood, M. E., Turner, A. A., Ramsay, H. R., & Hopper, J. N. (1979). An exploratory study of the cognitive strustures underlying the comprehension of software design problems *Technical Report*. Alexandria, VA.

Aurum, A., & Wohlin, C. (2003). The Fundamental Nature of Requirements Engineering Activities as a Decision-Making Process. *Information and Software Technology, 45*(14), 945-954.

Aurum, A., & Wohlin, C. (2005). Requirements Engineering: Setting the Context. In A. Aurum & C. Wohlin (Eds.), *Engineering and Managing Software Requirements* (pp. 1-15): Springer Berlin Heidelberg.

Austin, A. E. (2009). Cognitive apprenticeship theory and its implications for doctoral education: A case example from a doctoral program in higher and adult education. *International Journal for Academic Development, 14*(3), 173-183.

Avison, D. E., & Fitzgerald, G. (2003). Where now for development methodologies? *COMMUNICATIONS OF THE ACM January 2003/Vol. 46, No. 1, 46*(1), 79-82.

Baccarini, D., Salm, G., & Love , P. E. D. (2004). Management of risks in information technology projects. *Industrial Management & Data Systems, 104*(4), 286 - 295.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37*(2), 122.

Basholli, A., Baxhaku, F., Dranidis, D., & Hatziapostolou, T. (2013). *Fair assessment in software engineering capstone projects*. Paper presented at the Proceedings of the 6th Balkan Conference in Informatics, Thessaloniki, Greece.

Batra, D., & Davis, J. G. (1989). *A study of conceptual data modeling in database design: similarities and differences between expert and novice designers*. Paper presented at the Proceedings of the tenth international conference on Information Systems, Boston, Massachusetts, United States.

Batra, D., & Davis, J. G. (1992). Conceptual data modelling in database design: similarities and differences between expert and novice designers. *International Journal of Man-Machine Studies, 37*(1), 83-101. doi: Doi: 10.1016/0020-7373(92)90092-y

Batra, D., & Satzinger, J. W. (2006). Contemporary Approaches and Techniques for the Systems Analyst. *Journal of Information Systems Education, 17*(3), 9.

Bell, C. C., Mills, R. J., & Fadel, K. J. (2013). An Analysis of Undergraduate Information Systems Curricula: Adoption of the IS 2010 Curriculum Guidelines. *Communications of the Association for Information Systems, 32*, 22.

Ben-Ari, M. (1998). *Constructivism in computer science education.* Paper presented at the ACM SIGCSE Bulletin.

Ben-Ari, M. (2001). Constructivism in Computer Science Education. *Journal of Computers in Mathematics and Science Teaching, 20*(1), 45-73.

Beyerlein, S., Davis, D., Trevisan, M., Thompson, P., & Harrison, K. (2006). *Assessment framework for capstone design courses.* Paper presented at the Proceedings of the American Society for Engineering Education Annual Conference & Exposition.

Biørnstad, B. (2007). Understanding groups–a review of models. *Innovation in Action–the development*, 55.

Bostrom, R. P. (1989). Successful application of communication techniques to improve the systems
development process. *Information & Management, 16*(5), 279-295.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How People Learn: Brain, Mind, Experience, and School: Expanded Edition*. Washington, D.C.: National Academy Press.

Braun, V., & Clark, V. (2006). Using Thematic Analysis in Psychology. *Qualitative Research in Psychology, 3*, 77-101.

Brennan, K. (2009). *A guide to the business analysis body of knowledge (Babok Guide)*: International Institute of business analysis.

Brooks, C. M., & Ammons, J. L. (2003). Free riding in group projects and the effects of timing, frequency, and specificity of criteria in peer assessments. *Journal of Education for Business, 78*(5), 268-272.

Brown, A. L. (1978). Knowing when, where, and how to remember: A problem of metacognition.

Brown, H. I. (1988). *Rationality*. London, New York: Routledge.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32- 42.

Bruning, R. H., Schraw, G. J., & Ronning, R. R. (1999). *Cognitive psychology and instruction* (3 ed.). Upper Saddle River, N.J. : Merrill.

Bubenko, J. (1995). *Challenges in Requirements Engineering: keynote address.* Paper presented at the Second IEEE International Symposium on Requirements Engineering, York, England.

Buetow, S. (2010). Thematic analysis and its reconceptualization as 'saliency analysis'. *Journal of Health Services Research & Policy, 15*(2), 123-125.

Bullen, C. V. (2007). IT Workforce Trends: Implications for Curriculum and Hiring. *Communications of the Association for Information Systems, 20*, 545-554.

Bullen, C. V., Abraham, T., Gallagher, K., Simon, J. C., & Zwieg, P. (2009). IT workforce trends: Implications for curriculum and hiring. *Communications of the Association for Information Systems, 24*(1), 129-140.

Byrd, T. A., Cossick, K. L., & Zmud, R. W. (1992). A synthesis of research on requirements analysis and knowledge acquisition techniques. *MIS Quarterly, 16*(1), 117-138.

Cader, R., Campbell, S., & Watson, D. (2005). Cognitive Continuum Theory in nursing decision-making. *Journal of Advanced Nursing, 49*(4), 397-405.

Calhoun, D. C. (2014). *Teaching Teamwork to College Students through Cooperative Learning: Faculty Attitudes and Instructional Best Practices.* NOTRE DAME OF MARYLAND UNIVERSITY.

Carlsson, S. A., Hedman, J., & Steen, O. (2010a). Integrated Curriculum for a Bachelor of Science in Business Information Systems Design (BISD 2010). *Communications of the Association for Information Systems, 26*.

Carlsson, S. A., Hedman, J., & Steen, O. (2010b). Integrated curriculum for a bachelor of science in business information systems design (BISD 2010). *Communications of the Association for Information Systems, 26*(1), 24.

Carraccio, C. L., Benson, B. J., Nixon, L. J., & Derstine, P. L. (2008). From the educational bench to the clinical bedside: translating the Dreyfus developmental model to the learning of clinical skills. *Academic Medicine, 83*(8), 761-767.

Cervero, R. M. (1992). Professional practice, learning, and continuing education: an integrated perspective‡. *International Journal of Lifelong Education, 11*(2), 91-101.

Chakraborty, S., Sarker, S., & Sarker, S. (2010). An Exploration into the Process of Requirements Elicitation: A Grounded Approach. *Journal of the Association for Information Systems, 11*(4), 212-249.

Chakravorty, S. S., Hales, D. N., & Herbert, J. I. (2008). How problem-solving really works. *Int. J. Data Analysis Techniques and Strategies, 1*(1), 44-59.

Chapman, K. J., Meuter, M., Toy, D., & Wright, L. (2006). Can't we pick our own groups? The influence of group selection method on group dynamics and outcomes. *Journal of Management Education, 30*(4), 557-569.

Chase, W. G., & Simon, H. A. (1973a). The mind's eye in chess. In W. G. Chase (Ed.), *Visual information processing* (pp. 215-281). New York: Academic Press.

Chase, W. G., & Simon, H. A. (1973b). Perception in chess. *Cognitive Psychology, 4*(1), 55-81.

Chiaburu, D. S., & Lindsay, D. R. (2008). Can do or will do? The importance of self-efficacy and instrumentality for training transfer. *Human Resource Development International, 11*(2), 199-206.

Chilton, M. A., McHaney, R., & Chae, B. (2006). Data Modeling Education: The Changing Technology. *Journal of Information Systems Education, 17*(1), 17-21.

Christiaans, H., & Dorst, C. (1992). Cognitive Models in Industrial Design Engineering: a protocol study. In D. L. T. a. D. A & Stauer (Eds.), *Design Theory and Methodology - DTM92, American Society of Mechanical Engineers*. New York, USA.

Clark, A. (1997). *Being There: Putting Mind, Body, and World Together Again*. Cambridge, MA: MIT Press.

Collins, A., Brown, S. B., & Holum, A. (1991). Cognitive apprenticeship: Making thinking visible. *American Educator, 15*(3), 4- 46.

Connolly, T., M , & Begg, C. E. (2006). A Constructivist-Based Approach to Teaching Database Analysis and Design. *Journal of Information Systems Education, 17*(1), 43-54.

Cope, C. (2002). Educationally Critical Aspects of the Concept of an Information System. *Informing Science, 5*(2), 67-79.

Cope, C. (2003). Educationally Critical Characteristics of Deep Approaches to Learning about the Concept of an Information System. *Journal of Information Technology Education, 2*, 415-427.

Cope, C., Horan, P., & Garner, M. (1997). Conceptions of an Information System and Their Use in Teaching about IS. *Informing Science, 1*(1), 9-22.

Creswell, J. W. (2013). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.): SAGE Publications.

Cross, N. (2004). Expertise in design: an overview. *Design Studies, 25*(5), 427-441. doi: http://dx.doi.org/10.1016/j.destud.2004.06.002

Crotty, M. (1998). *The Foundations of Social Research*
*Meaning and Perspective in the Research Process*: Sage Publications Ltd.

Curtis, B., Krasner, H., & Iscoe, N. (1988). A Field Study of the Software Design Process for Large Systems. *Communications of the ACM, 31*(11), 1268-1287.

Curtis, B., Walz, D., & Elam, J. (1990). *Studying the process of software design teams*. Paper presented at the Proceedings of the 5th international software process workshop on Experience with software process models, Kennebunkport, Maine, United States.

d'Entreves, M. P. (2006). Hannah Arendt. *Stanford Encyclopedia of Philosophy on line*. http://plato.stanford.edu/entries/arendt/

Dancy, J. (2004). *Ethics without principles*. Oxford: Oxford University Press.

Dane, E., & Pratt, M. G. (2007). Exploring intuition and its role in managerial decision making. *Academy of Management Review, 32*(1), 33-54.

Darabi, A. A. (2005). Application of the Cognitive Apprenticeship Model to a Graduate Course in Performance Systems Analysis: A Case Study. *Educational Technology Research and Development, 53*(1), 49-61.

Darley, J. M., & Latane, B. (1968). Bystander intervention in emergencies: diffusion of responsibility. *Journal of personality and social psychology, 8*(4p1), 377.

Davey, B., & Cope, C. (2008). Requirements Elicitation – What's Missing? *Issues in Informing Science and Information Technology, 5*.

Davies, I. G., Green, P., Rosemann, M., Indulska, M., & Gallo, S. (2006). How do practitioners use conceptual modeling in practice? *Data & Knowledge Engineering, 58*(3), 358-380. doi: DOI: 10.1016/j.datak.2005.07.007

Davies, I. G., Green, P. F., Rosemann, M., & Gallo, S. (2004). *Conceptual Modelling - What and Why in Current Practice.* Paper presented at the 23rd International Conference on Conceptual Modelling (ER'04), Shanghai, China.

Davis, A., Dieste, O., Hickey, A. M., Juristo, N., & Moreno, A. M. (2006). *Effectiveness of requirements elicitation techniques: Empirical results derived from a systematic review.* Paper presented at the RE'06: 14th IEEE International Requirements Engineering Conference, Proceedings, Los Alamitos.

Davis, C. J., Fuller, R. M., Tremblay, M. C., & Berndt, D. J. (2006). Communication challenges in requirements elicitation and the use of the repertory grid technique. *Journal of Computer Information Systems, 46*(5), 78.

de Groot, A. D. (1978). *Thought and choice in chess* (Vol. 4): Walter de Gruyter.

Deeter-Schmelz, D. R., Kennedy, K. N., & Ramsey, R. P. (2002). Enriching our understanding of student team effectiveness. *Journal of Marketing Education, 24*(2), 114-124.

DeGrace, P., & Stahl, L. H. (1990). *Wicked problems, righteous solutions*: Yourdon Press.

Delson, N. J. (2001). Increasing team motivation in engineering design courses. *International Journal of Engineering Education, 17*(4/5), 359-366.

Dennen, V. P., & Burner, K. J. (2008). The cognitive apprenticeship model in educational practice. *Handbook of research on educational communications and technology, 3*, 425-439.

Doyle, S., McDonald, L., & Leberman, S. (2012). *The Transfer of Learning: Participants' Perspectives of Adult Education and Training* Gower Publishing, Ltd.

Dreyfus, H. L., & Dreyfus, S. E. (1986). *Mind over Machine: the power of human intuition and expertise in the age of the computer*. Oxford: Basil Blackwell.

Dreyfus, S. E. (2004). The Five-Stage Model of Adult Skill Acquisition. *Bulletin of Science Technology & Society, 24*.

Dreyfus, S. E., & Dreyfus, H. L. (1980). *A five-stage model of the mental activities involved in directed skill acquisition*. Unpublished report supported by the Air Force Office of Scientific Research, USAF (contract F49620-79-C0063). University of California, Berkeley.

Dunne, E., & Rawlins, M. (2000). Bridging the Gap Between Industry and Higher Education: Training Academics to Promote Student Teamwork. *Innovations in Education & Training International, 37*(4), 361-371. doi: 10.1080/135580000750052973

Egan, G. (2013). *The skilled helper: A problem-management and opportunity-development approach to helping*: Cengage Learning.

Einhorn, H. J., & Hogarth, R. M. (1981). Behavioral decision theory: Processes of judgment and choice. *Journal of Accounting Research*, 1-31.

Elo, S., Kääriäinen, M., Kanste, O., Pölkki, T., Utriainen, K., & Kyngäs, H. (2014). *Qualitative Content Analysis* (Vol. 4).

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing, 62*(1), 107-115.

Ericsson, K. A. (2002). Attaining excellence through deliberate practice: Insights from the study of expert performance. In M. Ferrari (Ed.), *The pursuit of excellence in education* (pp. 21-55). Hillsdale, N.J.: Erlbaum.

Ericsson, K. A. (2004). Deliberate Practice and the Acquisition and Maintenance of Expert Performance in Medicine and Related Domains. *Academic Medicine, 79*(10), S70-S81.

Ericsson, K. A. (2006). The Influence of experience and deliberate practice on the development of superior expert performance. In K. A. Ericsson, C. N, F. P. J & H. R. R (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 683-704). New York, NY: Cambridge University Press.

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. *Psychological Review, 102*(2), 211.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*(3), 363.

Ericsson, K. A., & Lehmann, A. C. (1996). EXPERT AND EXCEPTIONAL PERFORMANCE: Evidence of Maximal Adaptation to Task Constraints. *Annual Review of Psychology, 47*(1), 273-305. doi: doi:10.1146/annurev.psych.47.1.273

Eteläpelto, A. (1998). *The development of expertise in information systems design*: University of Jyväskylä.

Farrell, V., Farrell, G., Kindler, P., Ravalli, G., & Hall, D. (2013). *Capstone project online assessment tool without the paper work*. Paper presented at the Proceedings of the 18th ACM conference on Innovation and technology in computer science education, Canterbury, England, UK.

Farrell, V., Ravalli, G., Farrell, G., Kindler, P., & Hall, D. (2012). *Capstone project: fair, just and accountable assessment*. Paper presented at the Proceedings of the 17th ACM annual conference on Innovation and technology in computer science education, Haifa, Israel.

Feldgen, M., & Clua, O. (2010). *Reflections of nine years of interdisciplinary capstone courses.* Paper presented at the Frontiers in Education Conference (FIE), 2010 IEEE.

Fitzgerald, B. (1997). The use of systems development methodologies in practice:a field study. *Info Systems J, 7*, 201-212.

Fitzgerald, B. (1998, December, 1998). *An Empirically-Grounded Framework for the Information Systems Development Process.* Paper presented at the Proceedings of the International Conference on Information Systems.

Flavell, J. H. (1976). Metacognitive aspects of problem solving In R. L. B. (Ed.), *The nature of intelligence* (pp. 231-236). Hillsdale, NJ: Erlbaum

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34*(10), 906-901.

Fowlkes, J. E., Salas, E., Baker, D. P., Cannon-Bowers, J. A., & Stout, R. J. (2000). The utility of event-based knowledge elicitation. *Human Factors, 42*(1), 24-35. doi: 10.1518/001872000779656615

Fox, T. L. (2002). A case analysis of real-world systems development experiences of CIS students. *Journal of Information Systems Education, 13*(4), 343-350.

Garner, R. (1987). *Metacognition and reading comprehension*: Ablex Publishing.

Garner, R. (1988). Verbal-report data on cognitive and metacognitive strategies. *Learning and study strategies: Issues in assessment, instruction, and evaluation*, 63-76.

Gasson, S. (2006). A genealogical study of boundary-spanning IS design. *European Journal Information Systems, 15*(1), 16.

Ge, X., & Land, S. M. (2003). Scaffolding Students' Problem-Solving Processes in an Ill-Structured Task Using Question Prompts and Peer Interactions. *Educational Technology Research and Development, 51*(1), 21-38.

Geske, J. (2009). Order from chaos: Assessment and evaluation of design in a team environment. *International Journal of Learning, 15*(11), 23-31.

Gibbings, P., & Snook, C. (2013). *Benchmarking of final year engineering projects.* Paper presented at the Proceedings of the 24th Annual Conference of the Australasian Association for Engineering Education (AAEE 2013).

Gigerenzer, G. ( 2008). Why heuristics work. *Perspect. Psychol. Sci., 3*(1), 20-29.

Gigerenzer, G., & Goldstein, D. G. (1996). Reasoning the Fast and Frugal Way: Models of Bounded Rationality. *Psychological Review, 103*(4), 650-669.

Gobet, F. (1996). *Discrimination nets, production systems and semantic networks: Elements of a unified framework.* Paper presented at the Proceedings of the 1996 International Conference on Learning sciences.

Gobet, F. (1997). A pattern-recognition theory of search in expert problem solving. *Thinking & Reasoning, 3*(4), 291-313.

Gobet, F. (2005). Chunking Models of Expertise: Implications for Education. *Applied Cognitive Psychology, 19*, 183-204.

Goleman, D. (1995). *Emotional Intelligence*. New York, NY, England: Bantam Books, Inc.

Gorgone, J. T., Gray, P., Stohr, E. A., Valacich, J. S., & Wigand, R. T. (2006). MSIS 2006 model curriculum and guidelines for graduate degree programs in information systems. *Communications of the Association for Information Systems, 17*(1).

Green, P. (2005). A rigorous journey into phenomenography: From a naturalistic inquirer viewpoint. In J. A. Bowden & P. Green (Eds.), *Doing Developmental Phenomenography*. Melbourne: RMIT University Press.

Grossman, R., & Salas, E. (2011). The transfer of training: what really matters. *International Journal of Training and Development, 15*(2), 103-120. doi: 10.1111/j.1468-2419.2011.00373.x

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research, 2*(163-194).

Guindon, R. (1990). Knowledge exploited by experts during software system design. *International Journal of Man-Machine Studies, 33*(3), 279-304.

Guindon, R., & Curtis, A. B. (1988). *Control of cognitive processes during software design: what tools are needed?* Paper presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Washington, D.C., USA.

Gupta, J. N. D., & Wachter, R. M. (1998). A Capstone Course in the Information Systems Curriculum. *International Journal of Information Management, 18*(6), 427-441. doi: http://dx.doi.org/10.1016/S0268-4012(98)00033-4

Hadjerrouit, S. (1999). *A Constructivist Approach to Object-Oriented Design and Programming*. Paper presented at the 4th Annual SIGCSE/SIGCUE Conference on Innovation and Technology in Computer Science Education (ITiCSE'99), Cracow, Poland.

Hager, P. (2000). Know-How and Workplace Practical Judgment. *Journal of Philosophy of Education, 34*(2), 281-296.

Hambrick, D. Z., Oswald, F. L., Altmann, E. M., Meinz, E. J., Gobet, F., & Campitelli, G. (2014). Deliberate practice: Is that all it takes to become an expert? *Intelligence, 45*(0), 34-35. doi: http://dx.doi.org/10.1016/j.intell.2013.04.001

Hanoch, Y. (2002). "Neither an angel nor an ant": Emotion as an aid to bounded rationality. *Journal of Economic Psychology, 23*(1), 1-25.

Hansen, R. S. (2006). Benefits and Problems With Student Teams: Suggestions for Improving Team Projects. *Journal of Education for Business, 82*(1), 11-19. doi: 10.3200/JOEB.82.1.11-19

Harris, A. H., Greer, T. H., Morris, S. A., & Clark, W. J. (2012). Information Systems Job Market Late 1970's-Early 2010's. *Journal of Computer Information Systems, 53*(1), 8.

Healy, P. (1993). Rationality, Judgment and Critical Inquiry. *The Electronic Journal of Analytic Philosophy, 1*(3). http://ejap.louisiana.edu/EJAP/1993.august/healy.html

Hickey, A. M., & Davis, A. M. (2003). *Elicitation Technique Selection: How Do Experts Do It?* Paper presented at the Proceedings of the 11th IEEE International Conference on Requirements Engineering.

Hickey, A. M., & Davis, A. M. (2004). A Unified Model of Requirements Elicitation. *Journal of Management Information Systems, 20*(4), 65-84.

Hirsch, P. L., & McKenna, A. F. (2008). Using reflection to promote teamwork understanding in engineering design education. *International Journal of Engineering Education, 24*(2), 377-385.

Hirsch, P. L., Shwom, B. L., Yarnoff, C., Anderson, J. C., Kelso, D. M., Olson, G. B., & Colgate, J. E. (2001). Engineering design and communication: The case for interdisciplinary collaboration. *International Journal of Engineering Education, 17*(4/5), 343-348.

Ho, C. H. (2001). Some phenomena of problem decomposition strategy for design thinking: dierences between novices and experts. *Design Studies, 22*, 27-45.

Hoffmann, O., Cropley, D., Cropley, A., Nguyen, L., & Swatman, P. (2007). Creativity, requirements and perspectives. *Australasian Journal of Information Systems, 13*(1).

Hogarth, R. M. (2001). *Educating intuition*: University of Chicago Press.
Houdek, F., & Pohl, K. (2000, 2000). *Analyzing requirements engineering processes: a case study.* Paper presented at the Database and Expert Systems Applications, 2000. Proceedings. 11th International Workshop on.
Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277-1288.
Huang, I.-L. (2009). *A Review of the Differences between Novices and Experts in Specifying Information Requirements.* Paper presented at the Allied Academies International Conference, Las Vegas, Nevada.
Huang, I. L., & Burns, J. R. (2000). *A cognitive comparison of modeling behaviors between novice and expert information analysts.* Paper presented at the Americas Conference on Information Systems (AMCIS).
Iivari, J., Hirschheim, R., & Klein, H. K. (2001). *Towards More Professional Information Systems Development:: ISD as Knowledge Work.* Paper presented at the Global Co-Operation in the New Millennium: The 9th European Conference on Information Systems, Bled, Slovenia.
Iivari, J., Hirschheim, R., & Klein, H. K. (2004). Towards a distinctive body of knowledge for Information Systems experts: coding ISD process knowledge in two IS journals. *Information Systems Journal, 14*(4), 313-342. doi: 10.1111/j.1365-2575.2004.00177.x
Jay, A. (1980). *Nobody's perfect-but a team can be*.
Kakabadse, N. K., Louchart, E., & Kakabadse, A. (2006). Consultant's role: a qualitative inquiry from the consultant's perspective. *Journal of Management Development, 25*(5), 416-500.
Katzenbach, J. R., & Smith, D. K. (1993). The wisdom of teams, 1993. *Harvard Business School Press, Boston MA*.
Kauppinen, M., Savolainen, J., & Mannisto, T. (2007). *Requirements engineering as a driver for innovations.* Paper presented at the Requirements Engineering Conference, 2007. RE'07. 15th IEEE International.
Kautz, K., Hansen, B., & Jacobsen, D. (2004). The utilization of information systems development methodologies in practice,. *Journal of Information Technology Education, Cases and Applications, 6*(4).
Keefe, M., Glancey, J., & Cloud, N. (2007). Assessing student team performance in industry sponsored design projects. *Journal of Mechanical Design, 129*(7), 692-700.
Keen, P. G. W. (1981). Information systems and organizational change. *Commun. ACM, 24*(1), 24-33. doi: http://doi.acm.org/10.1145/358527.358543
Keil, M., Cule, P. E., Lyytinen, K., & Schmidt, R. C. (1998). A framework for identifying software project risks. *Communications of the ACM, 41*(11), 76-83.
Kendall, K. E., & Kendall, J. E. (2014). *Systems Analysis and Design* (9 ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
Khan, M. B., & Kukalis, S. (1990). MIS professionals: Education and performance. *Information & Management, 19*(4), 249-255. doi: http://dx.doi.org/10.1016/0378-7206(90)90034-F
Kiefel , H. J. S. (2012). Reasons for judgment: objects and observations. from www.hcourt.gov.au/assets/publications/.../kiefelj-2012-05-18.pdf
Kirby, J. M. (1990). On the Writing of Judgments. *Australian Law Journal, 64*.
Kleeman, D. (2005). *Reflections on the teaching of SSM* Paper presented at the 16th Australasian Conference on Information Systems, Sydney.
Klein, G. (1998). *Sources of power: How people make decisions.* Cambridge, MA: MIT Press.

Klein, G. (2003). *Intuition at work*. New York: Doubleday.
Kolodner, J. L., & Wills, L. M. (1996). Powers of observation in creative design. *Design Studies, 17*(4), 385-416. doi: http://dx.doi.org/10.1016/S0142-694X(96)00021-X
Kotonya, G., & Sommerville, I. (1998). *Requirements Engineering - Processes and Techniques*. UK: John Wiley & Sons.
Kulkarni, G. (2012). Cloud Computing-Software as Service. *International Journal of Cloud Computing and Services Science (IJ-CLOSER), 1*(1), 11-16.
Lajoie, S. P. (2009). Developing professional expertise with a cognitive apprenticeship model: Examples from avionics and medicine. *Development of professional expertise: Toward measurement of expert performance and design of optimal learning environments*, 61-83.
Lakoff, G., & Johnson, M. (1980). *Metaphors We Live By*. Chicago: University of Chicago Press.
Lang, M., & Fitzgerald, B. (2006). New Branches, Old Roots: A Study of Methods and Techniques in Web / Hypermedia Systems Design. *Information Systems Management, 23*(3), 62-74.
Larochelle, M., Bednarz, N., & Garrison, J. W. (1998). *Constructivism and education*: Cambridge University Press.
Lau, K., Beckman, S. L., & Agogino, A. M. (2012). Diversity in design teams: An investigation of learning styles and their impact on team performance and innovation. *International Journal of Engineering Education, 28*(2), 293.
Leberman, S., McDonald, L., & Doyle, S. (2006). *The transfer of learning: Participants' perspectives of adult education and training*: Gower Publishing, Ltd.
Lee, P. C. B. (2006). Information Technology Professionals' Skill Requirements in Hong Kong. *Contemporary Management Research, 2*(2), 141-152.
Lincoln, Y. S. (1995). Emerging Criteria for Quality in Qualitative and Interpretive Research. *Qualitative inquiry, 1*(3), 275-289. doi: 10.1177/107780049500100301
Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry* (Vol. 75): Sage.
Lincoln, Y. S., & Guba, E. G. (1989). *Fourth generation evaluation*: Sage.
Lipman, M. (2003). *Thinking in Education* (2nd ed.). New York: Cambridge University Press,.
Lopez, T. B., & Lee, R. G. (2005). Five principles for workable client-based projects: Lessons from the trenches. *Journal of Marketing Education, 27*(2), 172-188.
Loucopoulos, P., & Karakostas, V. (1995). *System Requirements Engineering*: McGraw-Hill, Inc.
Luntley, M. (2005). The Character of Learning. *Educational Philosophy and Theory, 37*(5), 689-704. doi: 10.1111/j.1469-5812.2005.00151.x
Maciaszek, L. (2007). *Requirements analysis and system design*: Pearson Education.
Mackay, J. M., & Elam, J. J. (1992). A comparative study of how experts and novices use a decision aid to solve problems in complex knowledge domains. *Information Systems Research, 3*(2), 150-172.
Magoon, A. J. (1977). Constructivist approaches in educational research. *Review of Educational Research*, 651-693.
Maiden, N., & Robertson, S. (2005). *Integrating creativity into requirements processes: Experiences with an air traffic management system.* Paper presented at the Requirements Engineering, 2005. Proceedings. 13th IEEE International Conference on.

Maiden, N., Robertson, S., & Robertson, J. (2006). *Creative requirements: invention and its role in requirements engineering*. Paper presented at the Proceedings of the 28th international conference on Software engineering.

Maleki, R. A. (2009). Business and industry project-based capstone courses: Selecting projects and assessing learning outcomes. *Industry and Higher Education, 23*(2), 91-102.

Marakas, G. M., & Elam, J. J. (1998). Semantic Structuring in Analyst Acquisition and Representation of Facts in Requirements Analysis. *Information Systems Research, 9*(1), 27.

Marinelli, V., & Laplante, P. A. (2008). *Requirements Engineering: The State of the Practice Revisited.* (Master of Software Engineering Thesis), Penn State. Retrieved from Requirements Engineering: The State of the Practice Revisited

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud computing - The business perspective. *Decision Support Systems, 51*(1), 176-189.

Martin, S., Aurum, A., Ross, J., & Paech, B. (2002). *Requirements Engineering Process Models in Practice.* Paper presented at the CEUR Workshop.

Mathiassen, L., & Purao, S. (2002). Educating reflective systems developers. *Information Systems Journal, 12*(2), 81-102.

Mathiassen, L., Saarinen, T., Tuunanen, T., & Rossi, M. (2007). A Contigency Model for Requirements Development. *Journal of the Association for Information Systems, 8*(11), 569-597.

May, L. J. (1998). Major causes of software project failures. *CrossTalk: The Journal of Defense Software Engineering, 11*(6), 9-12.

McGinnes, S. (2000). *Conceptual Modelling - A Psychological Perspective.* (PhD), University of London, London.

McKendall, M. (2000). Teaching groups to become teams. *Journal of Education for Business, 75*(5), 277-282.

McKenzie, L. J., Trevisan, M. S., Davis, D. C., & Beyerlein, S. W. (2004). *Capstone design courses and assessment: A national study.* Paper presented at the Proceedings of the 2004 American Society of Engineering Education Annual Conference & Exposition.

McVee, M. B., Dunsmore, K., & Gavelek, J. R. (2005). Schema theory revisited. *Review of Educational Research, 75*(4), 531-566.

Meinz, E. J., & Hambrick, D. Z. (2010). Deliberate Practice Is Necessary but Not Sufficient to Explain Individual Differences in Piano Sight-Reading Skill: The Role of Working Memory Capacity. *Psychological Science, 21*(7), 914-919. doi: 10.1177/0956797610373933

Mellers, B. A. (1998). Decision-Making. *Encyclopedia of Cognitive Science*.

Melville, N., Kraemer, K., & Gurbaxani, V. (2004). Review: Information technology and organizational performance: An integrative model of IT business value. *MIS Quarterly, 28*(2), 283-322.

Mergendoller, J. R., & Thomas, J. W. (2000). *Managing project based learning: Principles from the field.* Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.

Merriam, S. B., & Leahy, B. (2005). Learning transfer: A review of the research in adult education and training. *PAACE Journal of lifelong learning, 14*(1), 1-24.

Michell, P., Reast, J., & Lynch, J. (1998). Exploring The Foundations Of Trust. *Journal of Marketing Management, 14*(1/3), 159-172.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63*(2), 81-97. doi: 10.1037/h0043158

Mills, G. R. (2013). *Values and value in design.* © Grant RW Mills.

Mintzberg, H., Raisinghani, D., & Theoret, A. (1976). The Structure of Unstructured Decision Process

*Administrative Science Quarterly*( June), 246-275.

Misic, M. M., & Graf, D. K. (2004). Systems analyst activities and skills in the new millennium. *Journal of Systems and Software, 71*(1-2), 31-36. doi: Doi: 10.1016/s0164-1212(02)00124-3

Murray, S., Ryan, J., & Pahl, C. (2003). *A tool-mediated cognitive apprenticeship approach for a computer engineering course.* Paper presented at the Advanced Learning Technologies, 2003. Proceedings. The 3rd IEEE International Conference on.

Neill, C. J., & Laplante, P. A. (2003). Requirements engineering: the state of the practice. *Software, IEEE, 20*(6), 40-45.

Nguyen, L., Armarego, J., & Swatman, P. (2005). Understanding requirements engineering process: a challenge for practice and education.

Nguyen, L., & Shanks, G. (2006). *A Conceptual Approach to Exploring Creativity in Requirements Engineering.* Paper presented at the ACIS 2006 Proceedings., Adelaide Convention Centre.

Nguyen, L., & Swatman, P. A. (2003). Managing the requirements engineering process. *Requirements Engineering, 8*(1), 55-68. doi: 10.1007/s00766-002-0136-y

Noel, J. (1999). On the varieties of phronesis. *Educational Philosophy and Theory, 31*(3), 273-289.

Noll, C. L., & Wilkins, M. (2002). Critical Skills of IS Professionals: A Model for Curriculum Development. *Journal of Information Technology Education, 1*(3).

Nuseibeh, B., & Easterbrook, S. (2000). *Requirements Engineering: A Roadmap*. Paper presented at the ICSE 2000.

Oakeshott, M. (1967). *Rationalism in politics and other essays*. London [etc.]: Methuen.

Oakley, B., Felder, R. M., Brent, R., & Elhajj, I. (2004). Turning student groups into effective teams. *Journal of student centered learning, 2*(1), 9-34.

Paré, G., & Jutras, J.-F. (2004). How Good Is the Professional's Aptitude in the Conceptual Understanding of Change Management? *The Communications of the Association for Information Systems, 14*(1), 65.

Paris, S. G., & Winograd, P. (1990). How metacognition can promote academic learning and instruction. *Dimensions of thinking and cognitive instruction, 1*, 15-51.

Paulik, M. J., & Krishnan, M. (2001). A competition-motivated capstone design course: the result of a fifteen-year evolution. *Education, IEEE Transactions on, 44*(1), 67-75.

Pea, R. D. (1986). Language-independent conceptual "bugs" in novice programming. *Journal of Educational Computing Research, 2*(1), 25-36.

Pembridge, J. J. (2011). *Mentoring in engineering capstone design courses: Beliefs and practices across disciplines.* Virginia Polytechnic Institute and State University.

Peña, A. (2010). The Dreyfus model of clinical problem-solving skills acquisition: a critical perspective. *Medical Education Online, 15*, 10.3402/meo.v3415i3400.4846. doi: 10.3402/meo.v15i0.4846

Petter, S. (2008). Managing user expectations on software projects: Lessons from the trenches. *International Journal of Project Management, 26*(7), 700-712. doi: http://dx.doi.org/10.1016/j.ijproman.2008.05.014

Piaget, J., Cook, M., & Norton, W. (1952). *The origins of intelligence in children* (Vol. 8): International Universities Press New York.

Pitts, M. G., & Browne, G. J. (2004). Stopping Behavior of Systems Analysts During Information Requirements Elicitation. *J. Manage. Inf. Syst., 21*(1), 203-226.

Pitts, M. G., & Browne, G. J. (2007). Improving requirements elicitation: an empirical investigation of procedural prompts. *Information Systems Journal, 17*(1), 89-110.

Plant, N. (1989). Managing the client relationship (with a little help from methodologies). *International Journal of Project Management, 7*(1), 33-35. doi: http://dx.doi.org/10.1016/0263-7863(89)90050-1

Plomin, R., Petrill, S. A., Plomin, R., & Petrill, S. A. (1997). Genetics and intelligence: What's new? *Intelligence, 24*(1), 53-77. doi: 10.1016/S0160-2896(97)90013-1

Pohl, K. (1993). *The three dimensions of requirements engineering.* Paper presented at the Advanced Information Systems Engineering.

Pohl, K. (1994). The three dimensions of requirements engineering: a framework and its applications. *Information systems, 19*(3), 243-258.

Pohl, K. (2010). *Requirements engineering: fundamentals, principles, and techniques*: Springer Publishing Company, Incorporated.

Polkinghorne, D. E. (2007). Validity issues in narrative research. *Qualitative inquiry, 13*(4), 471-486.

Potts, C., Takahashi, K., & Anton, A. I. (1994). Inquiry-based requirements analysis. *IEEE Software, 11*(1), 21-32.

Prietula, M. I., & Simon, H. A. (1989). The Experts in Your IVIidst. *Harvard Business Review*.

Ravalli, G., & Stojcevski, A. (2011, 27-30 September 2011). *Students perception of capstone projects.* Paper presented at the Proceedings of the 1st World Engineering Education Flash Week (WEE2011), Lisbon, Portugal.

Reber, A. S. (1989). Implicit learning and tacit knowledge. *Journal of Experimental Psychology: General, 118*, 219 -235.

Reber, A. S. (1992). The cognitive unconscious: An evolutionary perspective. *Consciousness and Cognition, 1*(2), 93-133. doi: http://dx.doi.org/10.1016/1053-8100(92)90051-B

Richman, H. B., Gobet, F., Staszewski, J. J., & Simon, H. A. (1996). Perceptual and memory processes in the acquisition of expert performance: The EPAM model. *The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games*, 167-187.

Ridley, D. S., Schutz, P. A., Glanz, R. S., & Weinstein, C. E. (1992). Self-regulated learning: the interactive influence of metacognitive awareness and goal-setting. *Journal of Experimental Education, 60*(4), 293-306.

Rikers, R., Schmidt, H. G., & Boshuizen, H. P. A. (2002). Effects of clinical case priming on the activation of encapsulated knowledge: differences between medical experts and subexperts. *Cognition and Instruction, 20*, 27-45.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences, 4*(2), 155-169.

Rosenblatt, H. J. (2013). *Systems Analysis and Design* (10 ed.): Cengage Learning.

Ryle, G. (2009). *The concept of mind*: Routledge.

Sandbergh, J. (1997). Are phenomenographic results reliable? *Higher Education Research & Development, 16*(2), 203-212.

Satzinger, J. W., B., J. R., & Burd, S. D. (2012). *Systems Analysis and Design in a Changing World* (6 ed.). Boston, MA: Course Technology, Cengage Learning.

Satzinger, J. W., Batra, D., & Heikki, T. (2007). Analysis and Design in the IS curriculum: Taking it to the next level. *Communications of the Association for Information Systems, 20*, 483-496.

Scaife, M., & Rogers, Y. (1996). External cognition: how do graphical representations work? *International Journal of Human-Computer Studies, 45*(2), 185-213.

Schein, E. H. (1990). A General Philosophy of Helping: Process Consultation. *Sloan Management Review, 31*(3), 57.

Schenk, K. D., Vitalari, N. P., & Davis, K. S. (1998). Differences between novice and expert systems analysts: what do we know and what do we do? *J. Manage. Inf. Syst., 15*(1), 9-50.

Schon, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. New York: Basic Books.

Schon, D. A. (1987). *Educating the Reflective Practitioner: Towards a New Design for Teaching in the Professions*. San Francisco: Jossey-Bass.

Schroeder, M. (2008). Value Theory. *The Stanford Encyclopedia of Philosophy (Summer 2012 Edition).* 2015, from http://plato.stanford.edu/archives/sum2012/entries/value-theory/

Schunk, D. H. (1984). Self-efficacy and classroom learning.

Schunk, D. H. (2004). *Learning Theories : an educational perspective* (4th ed.): Pearson Education.

Seger, C. A. (1994). Implicit learning. *Psychological Bulletin, 115*, 163-196.

Shanks, G. (1997). Conceptual Data Modelling: An Emprical Study of Expert and Novice data Modellers. *AJIS, 4*(2), 63-73.

Shelly, G. B., & Rosenblatt, H. J. (2011). *Systems Analysis and Design* (9th ed.): Cengage Learning.

Silvius, A. (2006). Does ROI matter? Insights into the true business value of IT. *Electronic Journal of Information Systems Evaluation, 6*(9), 93-104.

Simon, H. A. (1955). A behavioral model of rational choice. *Quarterly Journal of Economics, 69*(1), 99-118.

Simon, H. A. (1987). Making management decisions: The role
of intuition and emotion. *Academy of Management Executive, 1*(1), 57-64.

Simon, H. A. (1992). What is an “explanation” of behavior? *Psychological Science, 3*, 150-161.

Simon, H. A. (1996). *The sciences of the artificial* (3rd ed.). Cambridge, MA: MIT Press.

Simon, H. A., & Gilmartin, K. J. (1973). A simulation of memory for chess positions. *Cognitive Psychology, 5*, 29-46.

Simpson, E. (1992). Review [untitled]. *Nous, 26*(2), 236-238.

Simsion, G. (2007). *Data Modelling: Theory and Practice*: Technics Publications.

Simsion, G., Milton, S. K., & Shanks, G. (2012). Data modeling: Description or design? *Information & Management, 49*(3), 151-163.

Simsion, G., & Witt, G. (2004). *Data Modeling Essentials*: Elsevier Science.

Singley, M. K. (1989). *The transfer of cognitive skill*: Harvard University Press.

Slavin, R. E. (2006). *Educational Psychology : Theory and Practice* (8th Edition ed.): Pearson Education.

Smits, S. J., McLean, E. R., & Tanner, J. R. (1993). Managing high-achieving information systems professionals. *J. Manage. Inf. Syst., 9*(4), 103-120.

Spencer, L., Ritchie, J., Lewis, J., & Dillon, L. (2003). Quality in qualitative evaluation: a framework for assessing research evidence.

Stadler, M. A., & Frensch, P. A. (1998). *Handbook of implicit learning*. Thousand Oaks, CA: Sage.

Stalmeijer, R. E., Dolmans, D. H., Wolfhagen, I. H., & Scherpbier, A. J. (2009). Cognitive apprenticeship in clinical practice: can it stimulate learning in the opinion of students? *Advances in Health Sciences Education, 14*(4), 535-546.

Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. *Management decision, 39*(7), 551-556.

Stolterman, E. (1992). HOW SYSTEM DESIGNERS THINK ABOUT DESIGN AND METHODS Some Reflections Based on an Interview Study. *Scandinavian Journal of Information Systems,, 3*, 137-150.

Sutcliffe, A. G., & Maiden, N. A. M. (1992). Analysing the novice analyst: cognitive models in software engineering. *International Journal of Man-Machine Studies, 36*(5), 719-740. doi: Doi: 10.1016/0020-7373(92)90038-m

Tan, M. (1994). Establishing Mutual Understanding in Systems Design: An Empirical Study. *Journal of Management Information Systems, 10*(4), 159-182.

Taylor, D. G., Magleby, S. P., Todd, R. H., & Parkinson, A. R. (2001). Training faculty to coach capstone design teams. *International Journal of Engineering Education, 17*(4/5), 353-358.

Thomas, J., & Harden, A. (2007). Methods for the thematic synthesis of qualitative research in systematic reviews *NCRM Working Paper Series*. London: ESRC National Centre for Research Methods.

Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology*.

Thomas, J. W. (2000). A review of research on project-based learning.

Thorndike, E. L., & Woodworth, R. S. (1901). The influence of improvement in one mental function upon the efficiency of other functions. *Psychological Review, 9*, 374-382.

Thorne, S., Jensen, L., Kearney, M. H., G, N., & M, S. (2004). Qualitative meta-synthesis: reflections on methodological orientation and ideological agenda. *Qualitative Health Research, 14*, 1342-1365.

Tiernan, C., & Peppard, J. (2004). Information Technology:: Of Value or a Vulture? *European Management Journal, 22*(6), 609-623.

Tobin, K. G. (1993). *The practice of constructivism in science education*: Psychology Press.

Topi, H., Helfert, M., Ramesh, V., Wigand, R. T., & Wright, R. T. (2011). Future of Master's Level Education in Information Systems. *Communications of the Association for Information Systems, 28*, 16.

Topi, H., Valacich, J. S., Wright, R. T., Kaiser, K., Nunamaker Jr., J. F., Sipior, J. C., & De Vreeda, G.-J. (2010). IS 2010 Curriculum Guidelines for Undergraduate Degree Programs in Information Systems. *Communications of the Association for Information Systems, 26*, 359-428.

Topi, H., Valacich, J. S., Wright, R. T., Kaiser, K. M., Nunamaker, J. F., Jr., Sipior, J. C., & de Vreede, G. J. (2010). IS 2010 Curriculum Guidelines for Undergraduate Degree Programs in Information Systems. http://www.acm.org/education/curricula-recommendations

Trigwell, K. (2000). *Phenomenography: variation and discernment.* Paper presented at the Improving student learning. Proceedings of the 1999 7th International Symposium.

Varela, F., Thompson, E., & Rosch, E. (1991). *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, MA: MIT Press.

Vasilevskaya, M., Broman, D., & Sandahl, K. (2014). *An assessment model for large project courses.* Paper presented at the SIGCSE.

Venable, J. (1995). Teaching Novice Conceptual Data Modellers to Become Experts.

Verma, G. (2010). *Software as a Service.* Paper presented at the ims.

Verner, J., Sampson, J., & Cerpa, N. (2008). *What factors lead to software project failure?* Paper presented at the Research Challenges in Information Science, 2008. RCIS 2008. Second International Conference on.

Vessey, I., & Conger, S. (1993). Learning to specify information requirements: The relationship between application and methodology. *Journal of Management Information Systems, 10*(2), 177-201.

Vitalari, N. P. (1985). Knowledge as a Basis for Expertise in Systems Analysis: An Empirical Study. *MIS Quarterly, 9*(3), 221-241.

Vitalari, N. P., & Dickson, G. (1983). Problem solving for effective systems analysis: an experimental exploration. *Communications of the ACM, 26*(11), 948-956.

Von Glasersfeld, E. (1989). Constructivism in education.

Vongsavanh, A., & Campbell, B. (2008). *The Roles and Skill Sets of Systems vs Business Analysts*. Paper presented at the 19th Australian Conference on Information Systems, Christchurch.

Vygotsky, L., Hanfmann, E., & Vakar, G. (2012). *Thought and language*: MIT press.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wai, J. (2013). Experts are born, then made: Combining prospective and retrospective longitudinal data shows that cognitive ability matters. *Intelligence, in press*.

Walczak, M. (1998). The Classical Conception Of Rationality. http://www.bu.edu/wcp/Papers/TKno/TKnoWalc.htm

Watson, H. J., & Frolick, M. N. (1993). Determining information requirements for an EIS. *MIS Quarterly, 17*(3), 255-269.

Weick, K. (1995). *Sensemaking in organizations*. Thousand Oaks, CA: Sage.

Wertsch, J. V. (1984). The zone of proximal development: Some conceptual issues. *New Directions for Child and Adolescent Development, 1984*(23), 7-18. doi: 10.1002/cd.23219842303

West, J. (2011). Ensuring success for client-based projects: an advertising course case study. *Journal for Advancement of Marketing Education, 19*, 1-10.

Wetherbe, J. C. (1991). Executive information requirements: Getting it right. *MIS Quarterly, 15*(1), 51-65.

Whitten, J., & Bentley, L. (2005). *Systems Analysis and Design Methods* (7 ed.): McGraw-Hill/Irwin.

Williams, B. C., Brian, H., Elger, D. F., & Schumacher, B. E. (2007). Peer evaluation as a motivator for improved team performance in Bio/Ag engineering design classes. *International Journal of Engineering Education, 23*(4), 698-704.

Wojahn, P., Dyke, J., Riley, L. A., Hensel, E., & Brown, S. C. (2001). Blurring Boundaries between Technical Communication and Engineering: Challenges of a Multidisciplinary, Client-Based Pedagogy. *Technical Communication Quarterly, 10*(2), 129-148. doi: 10.1207/s15427625tcq1002_2

Wynekoop, J. L., & Walz, D. B. (2000). Investigating traits of top performing software developers. *Information Technology & People, 13*(3), 186-195.

Yazici, S., Boyle, T., & Khan, T. (2001, August 28-30). *Towards a multimedia learning environment for object oriented design.* Paper presented at the 2nd Annual Conference of the LTSN Centre for Information and Computer Sciences, London.

Zave, P. (1997). Classification of research efforts in requirements engineering. *ACM Comput. Surv., 29*(4), 315-321. doi: http://doi.acm.org/10.1145/267580.267581

Zhang, Y., & Wildemuth, B. M. (2009). Qualitative analysis of content. *Applications of social research methods to questions in information and library science*, 308-319.

Zhou, Z., & Pazos, P. (2014). *Managing Engineering Capstone Design Teams: A Review of Critical Issues and Success Factors.* Paper presented at the Proceedings of the 2014 Industrial and Systems Engineering Research Conference, Montréal (Québec) Canada.

# 10 APPENDICES

# APPENDIX A – STUDENT JOURNAL QUESTIONS

## Journal 1 – Problems and requirements

*While dealing with your client, what were your observations about them and the workplace culture?*

This is a judgement question relating to understanding the environment and culture.

*How successful was the first interview? What were you using to measure success? Did the interview go as expected and if not what was different to your expectations?*

This is a judgement question relating to interviewing skills and problem determination. Asking for their "measure of success" was to get them to think about and articulate their criteria they were using to judge determine how well or badly the interview went. Students differ widely about what to expect from a first interview.

*Describe what you perceive to be the business problem, the vision of how things will be different assuming the problem is solved and the requirements to be met. To what extent do you believe that the project you are working on is realistic and of importance to the client? How relevant or interesting is the project to you?*

This is cognitive apprenticeship question relating to situated learning. How clearly does the student understand the problem from the business and client perspective as opposed to the information systems perspective? How realistic is the project and how interested does the client appear to be to have a solution? The second question tries to establish to what extent the project is motivating the student to take it seriously and put effort into it.

*Control strategies are things you do that determine if you are on track and, if not, to diagnose what the problem might be and help you to get you back on track. What control strategies do you have in place to ensure that you understand the problem, have an appropriate scope and that requirements are correct, comprehensive and measurable?*

This is a judgement question relating to the management and control processes adopted personally and by the team.

*What are your current thoughts about the problem, the scope and requirements? What needs to be done before the next interview (or other significant contact with the client such as a progress report or walkthrough)?*

> This is a judgement question relating to the management and control process mentioned in the previous question as to what extent it is understood and applied in practice.

*Having done the Myer Briggs test what is your suggested personality type? Does it appear to be substantially correct for you? If not, where does it appear to be incorrect? Was it helpful to you in any way to do this test?*

> This is a judgement question relating to self-understanding in terms of their personal strengths and weaknesses

*Compare yourself with your team mates across the four dimensions of E/I, S/N, T/F and J/P. Describe the potential problems that might arise given your particular mix of personality types.*

> This is a judgement question relating to understanding relationships between team members but also more broadly whether the team will have a broad mix of views and perspectives leading to better outcomes

*Team members need to agree on the project goals, standards and generally about how the team members operate. To what extent do you believe that your team has this agreement? What management and control strategies does your team have in place to ensure that you will finish on time, that all members have share the workload fairly and that work is of an acceptable standard?*

> This is a judgement and cognitive apprenticeship question relating to management and control strategies on team members and workload.

*By now you should have looked at some previous reports by previous project groups as well as other materials provided to assist you. You should have a reasonable idea as to what has to be done and standards to be achieved. How well do you believe you understand what you have to do in your project and the standards that will be applied?*

> This is a cognitive apprenticeship question relating to having a global or broad view of what is to happen. A good global view puts what they think or do in a larger context and provides justification and motivation for each task. It also relates to control strategy.

*Do you believe that you have learned something new or are learning anything significantly new from your other team members? What are these? These might be ideas* *or facts but they may also relate to attitudes, perspectives or ways of doing things related to communication, teamwork, leadership, organisational skills academic skills etc. Consider also that you might also be learning something by observing what appear to be others' mistakes, poor attitudes etc.*

This is a cognitive apprenticeship question relating to modelling behaviour.

*The meetings held each week with your academic supervisor and fellow team members are intended to encourage discussion to clarify ideas, highlight problems, suggest problem solving strategies and generally share ideas and viewpoints between the team members as well with the supervisor. What have been the most important outcomes from these discussions for you since the last journal?*

This is a cognitive apprenticeship question relating to modelling, learning from a coach and community of practice. It also tries to determine the effectiveness of the team-supervisor discussions in articulating ideas and improving understanding.

*Are there any tasks or issues that your supervisor assisted you with outside the weekly discussions? If so what were they? Would you still need assistance if the same task was required in future or do you believe you could handle it okay by yourself (you alone or with your team members).*

This is a cognitive apprenticeship question relating to coaching support and indirectly to scaffolding and fading.

*Is there anything that you believe could have been improved up to this point or could still be improved for the remainder of the semester?*

This is a cognitive apprenticeship question relating to finding gaps weaknesses in the teaching approach.

*Any other thoughts?*

This question is usually ignored by students but you never know what might come up.

## Journal 2 – Researching and finding solutions

*Describe the extent of your communications with your client organisation since your last journal. In what way(s) have they been productive? If not, what do you see as the problem(s)?*

This is a judgement question relating to client communication.

*Has there been any significant change in your understanding of the client's problem description and requirements in your project? If there have been significant changes what do you attribute this to? If there have been significant changes, with hindsight do you believe that you could have better determined these requirements at the beginning or not? If so, how? If not why not?*

This is a judgement question relating to their understanding of the problem and requirements. If the problem definition or requirements have been changing, possible causes might be the team not have done a satisfactory job in eliciting requirements or the discussions with the client have clarified or changed participants initial ideas.

*Control strategies are things you do that determine if you are on track and, if not, diagnose what the problem might be and helping to get you back on track. At this stage, these will relate to researching for possible solutions and finding the most satisfactory solutions which meeting the requirements and hence to solving the problem. What control strategies do you have in place to ensure that your research and finding solutions will be satisfactory?*

This is a cognitive apprenticeship question but also a judgement question relating to management and control of the task.

*How well are your management and control strategies working to ensure that you will finish on time, that all members have fairly share the workload and that work is of an acceptable standard?*

This is a cognitive apprenticeship question but also a judgement question relating to project management and control of people.

*How would you judge the team interaction at this stage? Whether it is good, bad or indifferent why do think it is going this way? Can you relate this to the interaction of your different personality types (from the Myer Briggs test) or something related to the small group communications work covered earlier this semester or something else?*

This is a cognitive apprenticeship question relating to cooperation. It is also a judgment question relating to the effectiveness of team interaction.

*What do you perceive as being your major contribution(s) to your team and (hopefully) the success of your project so far (for example, attention to detail, creativity, organisational skills, leadership, communication skills etc)? Is there anything (a role or task) that you wish you could do better?*

This is a judgment question relating to self-awareness.

*Since your last journal submission, do you believe that you have learned something new or are learning anything significantly new from your other team members? What are these? These might be ideas or facts but they may also relate to attitudes, perspectives or ways of doing things related to communication, teamwork, leadership, organisational skills etc. Consider also that you might also be learning something by observing what appear to be others' mistakes, poor attitudes etc.*

This is a cognitive apprenticeship question relating to modelling and also cooperation.

*The meetings held each week with your academic supervisor and fellow team members are intended to encourage discussion to clarify ideas, highlight problems, suggest problem solving strategies and generally share ideas and viewpoints between the team members as well with the supervisor. What have been the most important outcomes from these discussions for you since the last journal?*

This is a cognitive apprenticeship question relating to modelling, learning from a coach and community of practice. It also tries to determine the effectiveness of the discussions in articulating ideas and improving understanding.

*Since the last journal, are there any tasks or issues that your supervisor assisted you with? If so what were they? Would you still need assistance if the same task was required in future or do you believe you could handle it satisfactorily by yourself (or with your team members). Do you think that this assistance could have been provided in a better or different way?*

This is a cognitive apprenticeship question relating to coaching support and indirectly to scaffolding and fading.

*Is there anything that you believe could have been improved up to this point or could still be improved for the remainder of the semester?*

This is a cognitive apprenticeship question relating to finding gaps and weaknesses in the learning environment.

*Any other thoughts?*

This question is usually ignored by students but you never know what might come up.

## Journal 3 -Final reflections

*What were your aims in your final presentation? In what ways did it go particularly well or badly? Any there any aspects which you wish you had done differently or better in preparing for the presentation?*

This is judgement question related to understanding the audience and providing a presentation that will meet their needs and expectations. It also relates to being able to present an argument and to defend a position which is an important part of judgment.

*To what extent did you provide input into the final report? Did you feel that you understood what was required? What difficulties did you encounter either personally or from the perspective or coordinating and refining the work of the team members?*

This is a judgment and cognitive apprenticeship question. Ideally, the report needs to present a compelling and well-reasoned case which justifies the solutions or findings. It needs to satisfy both the client's and supervisor's expectations.

*The meetings held each week with your academic supervisor and fellow team members are intended to encourage discussion to clarify ideas, highlight problems, suggest problem solving strategies and generally share ideas and viewpoints between the team members as well with the supervisor. What have been the most important outcomes from these discussions for you since the last journal?*

This is a cognitive apprenticeship question relating to modelling, learning from a coach and community of practice. It also tries to determine the effectiveness of the discussions in articulating ideas and improving understanding.

*Since the last journal, are there any tasks or issues that your supervisor assisted you with? If so what were they? Do you think that this assistance could have been provided in a better or different way? Would you still need assistance if the same task was required in future or do you believe you could handle it okay by yourself (you alone or with your team members).*

This is a cognitive apprenticeship question relating to coaching support and indirectly to scaffolding and fading.

*What stands out to you as some of the more important principles or values that your supervisor has emphasized to you about projects like these? These may have been stated* *explicitly (i.e. directly in words) or they may have been implicit (i.e. not stated in words but implied through their attitudes or value judgments).*

This is a cognitive apprenticeship in that it asks for guiding principles demonstrated both explicitly and implicitly from their supervisor. It also a judgement question in ISAD since it asks for principles and values.

*Reviewing previous subjects you have done e.g. Systems Acquisition and Implementation Methodologies, Business Intelligence, Requirements Analysis and Modelling, Enterprise Systems, Process Modelling, Project Management what theories, knowledge, skills or processes did you find most relevant and appropriate to apply this project? (If you have many things that you could mention, just mention the ones that seemed most important to you)*

This is a judgment question since it asks them to link the work they have learned in prior subjects to the work in the project. Expertise requires one to be familiar with the body of knowledge, skills and practices of the profession. Responses here can be cross checked with the final reports and supervisors' observations.

*At which point in the project (if ever) did you feel that you understood what you were trying to achieve and how to get there? If you did, was there anything in particular that helped you with this or did your prior knowledge and experience make it obvious to you? If this understanding didn't come till the end or still is not there even now, what aspects didn't or don't you feel sure about?*

This is a cognitive apprenticeship question related to the global view and trying to pinpoint gaps or points of confusion. It is also a judgment question relating to understanding the task overall and goal setting.

*There will always be something new or different about each project. What new (or extension of existing) knowledge or skill have you had to acquire in the project that hasn't been taught in previous subjects? If so what was it? Was there anything that you believe is missing, not covered sufficiently well or not emphasized enough that would have prepared you better for the project?*

This is a cognitive apprenticeship question but also may relate to judgment.

*Now that the project is over, what do you think would be the key bits of advice you would give to beginning project students or you might apply in your next project?*

This is a judgment question since it reflects on the IS analysis process, skills and values. Posing the question in the form of advice to others suggests that it doesn't have to be anything new but may be practical application of what may have been theoretical before. Linking it to some later use is to get them to think about extending their application to other contexts.

*In Journal 1 you were asked to consider your personality type and that of your team members according to the Myer Briggs test and think about potential problems that might occur in your group as a result. Did you find that you and your team members behaved according to your stated types? You were asked to suggest potential problems that might occur because of the particular mix of personality types. Did any of these problems become apparent to you?*

This is a cognitive apprenticeship question related to cooperation but also a judgment question related to understanding of self and others and the interactions between people.

*As you think over your own personal and professional development this semester during the project, how useful did you find the environment that was set up this semester with its group discussions, presentations and supervisor guidance? Considering the learning environment and resources as a whole, what do you believe was the most valuable aspects for you? Were there any negatives?*

This is a cognitive apprenticeship question on the effectiveness of the discussions and overall environment of the subject. This is a cognitive apprenticeship question trying to gauge the importance of the various aspects of the cognitive apprenticeship environment. The amount of time spent on or words written about some aspect mentioned in answer to other questions of the project environment may not be a true reflection of importance to them.

*Any other thoughts?*

This question is usually ignored by students but you never know what might come up.

# APPENDIX B - SUPERVISOR QUESTIONS

## Related to Journal 1

*How well did the teams handle the first interviews? Consider how they prepared for, executed and followed up. What appeared to be lacking or poorly executed? How well do they appear to understand the problem, scope, requirements and the business context? What principles or values do you apply when deciding how well the teams are doing on this issue?*

This is a judgment question.

*Do students appear to have a satisfactory idea of the task, how to go about it and standards to be achieved at this stage? If not, what aspects do they appear unsatisfactory or misguided?*

This is a judgment question related to metacognitive skills and a cognitive apprenticeship question related to global knowledge.

*We aim to develop a "professional attitude" in students meaning a number of qualities regarded as appropriate and effective in a particular field. What are your observations about students' attitudes to the project and team work at this stage and are these attitudes significantly at variance from what you would regard as professional?*

This is a judgment question. The term "professional attitude" is often used but may not be well defined. Even if it has been defined, there is always the possibility (likelihood?) that what people do may not reflect what is espoused. What is seen as a "good" professional attitude varies not just with the profession but possibly also with the cultural context and time. This question attempts to elicit and differentiate between students' attitudes and those of someone working professionally as IS analysts in the local business context here in Australia.

*Do teams appear to be well organised at this point with satisfactory management and control strategies in place? If not, what are the weaknesses that you perceive?*

This is a judgment question related to metacognitive skills and a cognitive apprenticeship question related to management and control strategies.

*Do you detect any current or potential problems with the team member interaction? If so what is it?*

This is a judgment question related to team member interaction and a cognitive apprenticeship question related to cooperation.

*In what aspects have you provided support or guidance? Have you felt the need to more actively step in and direct students at any point?*

This is a cognitive apprenticeship question related to coaching support.

*The cognitive apprenticeship model suggests that students and supervisor need to make explicit their thinking processes. To what extent do you believe the weekly team and supervisor discussions are achieving their aims of clarifying ideas, highlighting problems, providing problem solving strategies and sharing ideas and viewpoints? How would you describe the interaction from your perspective and the role(s) have you mostly found yourself playing?*

This is a cognitive apprenticeship question related to making things visible.

*Is there anything that you believe could have been improved up to this point or could still be improved for the remainder of the semester?*

This is a cognitive apprenticeship question relating to finding gaps weaknesses in the teaching approach.

## Related to Journal 2

*Has there been any significant change in the client's description of the problem or requirements? If so, to what do you attribute this? From your perspective, could this change have been avoided or anticipated? Why or why not? How did students appear to cope with this change?*

This is a judgment question.

*As best as you can determine, how would you describe teams' management and control strategies as far as achieving the project aims on time, equitable sharing of work and achieving satisfactory standards are concerned? Are the strategies adequate and are they working?*

This is a judgment question.

*As best as you can determine, how would you describe teams' strategies in terms of researching and finding solutions? Do you have any concerns in this area?*

This is a judgment question.

*As best as you can determine, do the team members appear to working well together? Are there points of friction or disagreement? If so, do these points appear constructive or destructive? Do you perceive any problems in the group dynamic e.g. a person who is too dominating or controlling, team members who are too accommodating, members being excluded or unable to participate effectively, unmotivated members etc?*

This is a judgment question about team work. Overwhelming agreement might suggest team members who are too dominating or too accommodating or possibly so similar in thinking that different viewpoints are never considered.

*Since the last journal, in what ways have you provided support or guidance to students and teams? Are there any aspects with which you did earlier help them but now they operate independently?*

This is a cognitive apprenticeship question related to coaching, scaffolding and fading.

*Is there anything that you believe could have been improved up to this point or could still be improved for the remainder of the semester?*

This is a cognitive apprenticeship question relating to finding gaps weaknesses in the teaching approach.

## Related to Journal 3

*From your perspective, how well did teams handle their final presentation? If you provided guidance or advice to them prior to their final presentation what aspects needed most help? How would client presentations be different in a professional setting?*

> This is a judgment question since the presentation relates to presentation of findings and justifying judgments made and difference between the students' performance compared to performance expected from a practitioner. It is a cognitive apprenticeship question because it asks for the support provided.

*From your perspective, how well did teams handle their report? If you provided guidance or advice to them prior to submission of their report what aspects needed most help? What would be the most significant differences between the teams' reports that you saw and professionally produced ones?*

> This is a judgment question since the presentation relates to presentation of findings and justifying judgments made and difference between the students' performance compared to performance expected from a practitioner. It is a cognitive apprenticeship question because it asks for the support provided.

*Since the last journal, in what other ways have you provided support or guidance to students and teams e.g. in terms of research, working towards solutions, report writing etc? Are there any aspects with which you did earlier help them but now they operate independently?*

> This is a cognitive apprenticeship question relating to coaching support, scaffolding and fading.

*As the project has progressed, what stands out to you as some of the more important professional principles or values that you have emphasized to students? To what extent do you believe that there was a difference between your principles and values and that of students? Did this change during the project?*

> This is a judgment question relating to professional principles and values but a cognitive apprenticeship question relating to differences in expertise between student and supervisor.

*What is your evaluation of the teamwork skills demonstrated by students in each team i.e. personal, communication and organisational? Did anything stand out to you as* *being particularly well or poorly handled? Are the issues and challenges significantly different to those countered in practice?*

This is a judgment question related to cooperation and management and control strategies.

*Did students appear to lack knowledge or skills that you would have expected them to have (or be able recall quickly) prior to starting the project? How well did they handle acquiring new knowledge and skills?*

This is a judgment question related to expertise that students bring in to the project and ability to acquire new knowledge and skills.

*Did all students appear to have a reasonably clear understanding of what they were aiming for and doing during their project? Was this understanding apparent from the start, come later in the project or did some students never appear to achieve this understanding? If understanding came late or never do you have any suggestions as to why?*

This is a judgment and cognitive apprenticeship question related to students holistic understanding of the project.

*As you think over the students' personal and professional development this semester during the project, how useful did you find the weekly group meeting environment that was set up? Is there anything you gained out of this arrangement?*

This is a cognitive apprenticeship question related to the teaching environment particularly to the discussion aspects intended to make visible issues and thinking.

*From your own perspective as supervisor, is there anything that you would change in the way that you approached the project and teams in future? Why?*

This is a cognitive apprenticeship question related to the supervisor's reflection on his or her role.

*From an overall teaching perspective, is there anything that you suggest should be changed in the way this project subject is managed or in the existing teaching environment? Why?*

This is a cognitive apprenticeship question related to the supervisor's reflection on the teaching environment.

# APPENDIX C – STUDENT JOURNAL ANALYSIS - DETAILED

## Introduction

This appendix contains the detailed analysis of student journals submitted over the course of the semester for their capstone project unit. The appendix is subdivided into three major sections with each section corresponding to one journal. Within each journal there is a detailed analysis and summary of each question in the order that the questions were presented to students. For each question the results are typically presented as an overview followed by separate discussions for undergraduates and postgraduates. Questions 1 to 3 for Journal 1 will appear somewhat differently presented to the remainder of the questions in that journal and for questions in the other journals because for those three questions the themes were drawn from within the question itself. For all other questions the themes were drawn purely from student responses in a ground up manner.

To help with understanding and visualising the results, diagrams were developed for the great majority of questions. They begin at question 4 in Journal 1. These diagrams summarise the themes that students mentioned for that question by using an ellipse for each theme (characterised by a few words) together with the percentage of students responding with that theme. The thickness of the line for the ellipse corresponds directly to the percentage of students who responded with that theme. Two themes will sometimes be connected by straight lines with a percentage figure which indicates the percentage of students who mentioned both those two themes together in their response. Again, the thickness of the line was made to correspond directly to percentage of students who mentioned both themes. Where diagrams are provided for a question there will be one diagram for undergraduate students' responses and one for postgraduate students' responses. A threshold of 10% response rate was used for these diagrams (i.e. any theme or connection between themes less than 10% was ignored) to keep the diagrams manageable.

Note that the acronyms UG for undergraduate and PG for postgraduate have been used extensively within this appendix.

# Journal 1 Analysis

## Introduction

Journal 1 was submitted approximately a third of the way through the project around the end of the fourth week of the 12 week project. By then, teams had been through two interviews with the client and other stakeholders in order to understand the problem, its context, the client's aims and the project scope. They should have had at least two meetings with their expert supervisors during that time.

## Question 1 The client and the workplace

**While dealing with your client and possibly observing their workplace, what were your observations about them and the workplace culture?**

### Q1 Theme 1: Client and other stakeholders

*The purpose of this question was to determine the attention students put into the client and other stakeholders.*

*Overall*

On the whole all students appeared to have little direct interest in or knowledge about the people they were interviewing (not even mentioning, in most cases, names and job roles). Only one student (a postgraduate) correctly and fully named all those interviewed together with their job titles. 50% of postgraduates were attuned to the clients' emotional attitudes to the project compared to 20% of UGs. Clients' attitudes were described in terms such as interested, enthusiastic, helpful, supportive, serious and so on.

*UG: (21 students)*

Three students (14%) did not mention the client or other stakeholders at all in their answer.

Most students (67%) did not identify the client at all merely referring to him as the client. Some referred to him by his first name only and only three (14%) provided his full name and the department for which he worked. No-one identified his job role though some referred to him as an administrator. Of the three other stakeholders who were interviewed only one was named and then only by her first name. Only three students (14%) identified this stakeholder with one of her job functions as meeting organiser.

Two students described the client as enthusiastic; one described him as keen while another described the client and another stakeholder as “serious” about solving the problem.

*PG (14 students)*

Three students (21%) did not mention the client or other stakeholders at all in their answer.

Only one student (7%) named all the stakeholders participating in the interviewers together with their job titles. Another student named the key client but did not provide job roles or titles. Two other students (14%) attempted to describe job roles or descriptions mentioning; one student grouped them all as secretaries while the other student mentioned only that they were administrators and academics.

Seven students (50%) did mention that clients appeared to be very interested and enthusiastic about the project. Other adjectives used were helpful, supportive, excited, involved and motivated.

## Q1 Theme 2: Workplace culture

*The purpose of this question was to determine the attention they put into the workplace culture since this affects the type(s) of solution, information gathering, resistance to change, change management and training required.*

*Overall*

Overall, students did not appear to engage with this theme very well. One third of all students in both UG and PG groups made no attempt at all. While UGs discussed the importance of understanding workplace culture and cultural change only eight UG students (38%) attempted to describe the existing culture, typically in a word or two using terms such as “formal”, “professional”, “organised” and so on. Of the latter group only one student attempted any serious analysis. PGs engaged with this theme significantly less than UGs at both a theoretical and specific level; this might possibly be because PGs are less likely to have studied this topic or studied it to a lesser extent.

*UG: (21 students)*

Eight students (38%) did not mention workplace culture at all in their answers. Another eight students (38%) did provide a sentence or two using terms such as “*formal*”, "*professional*", "*organised*" and so on. Possibly the best attempt to describe the culture was this students view "*The organisations culture seems to be quite liberal and open. Information and the ability for it to be conversed seems a large cultural trait. Although a somewhat centralised organisational structure the information flow seems to counter this.*" One student went into some detail regarding the need to understand the workplace culture and the implications to the success of the project of not doing so but then did not attempt to describe the workplace culture. A student mentioned working in that environment but then made no attempt to describe the culture or any implications. One student thought workplace culture referred to the type of computer they used (i.e. Mac or PC).

*PG (14 students)*
Five students (36%) did not mention workplace culture at all. No strong themes emerged with the remaining students. Four students made very general comments regarding cultural change but nothing specific about the workplace culture operating in this project. More specific descriptions of the culture were that it was "dynamic" and that the people "work hard".

### Q1 Other Themes

Seventeen students in total brought up other issues in answer to this question. Most of these related to describing the clients problem, goals, project process or benefits. One student mentioned that his team had already found a solution and described some of the difficulties they might have convincing the client of the proposed (rather radical) solution.

## Question 2 Interview and its success

**How successful was the first interview? What was your measure of success? What aspects went as expected? What didn't go as expected? Look at this not just from the project point of view but also how it affected you personally.**

### Q2 Theme 1: Successfulness of interview(s)

*Overall*
Nearly all students thought that the first two interviews were successful. However around 40% of all students expressed dissatisfaction with the first interview. UGs disliked the open forum style of questioning either because not all their questions were

addressed or because they believed that other students were asking irrelevant questions. While postgraduates tended to appreciate that the first interview provided an overview of the problem and context it was not detailed and specific enough in addressing the requirements. One PG appreciated that others had thought of questions that they did not think to ask and another admitted that his team had had no idea what questions to ask. UGs appeared to have a stronger preference for controlling the questions being asked compared to PGs. There was virtually no dissatisfaction with the second interview because students had total control of the questions being asked and they believed they had obtained sufficient understanding of the problem and requirements to begin working on finding solutions.

*UG: 21 students*
Overall, virtually all students thought the two interviews were successful and informative. Eight students (38%) stated that the while the first interview provided some insight or understanding they didn't like it because they either they didn't get all their questions asked (one student complained that only 90% of his team's questions had been addressed) or that they didn't like the open forum style of asking questions where other students were asking questions they didn't think relevant. Many students suggested that they preferred the one-on-one style of the second interview session where stakeholders rotated amongst the teams to answer questions. Only one student thought the interviews were not successful because detailed descriptions and examples of all processes and documents had still not been provided.

*PG: 14 students*
While six students (43%) described the first interview was not very successful and the second one successful the reasons were more based around the insufficient detail in the first interview. Only one postgraduate expressed dislike of the first interview because of the open forum style. One student appreciated that questions had been asked that his team had not thought to ask while another student admitted that his team had been lost as to what to ask in the first interview but was much more confident and prepared for the second interview.

## Q2 Theme 2: Criteria for success

*Overall*

There was a significant difference in responses between UGs and PGs to this theme. While virtually all PGs mentioned understanding the problem and most (64%) mentioned determining problem scope as criteria for success, only 29% of UGs mentioned these. Similarly, 57% of PGs mentioned understanding the current environment or process while none of the UGs specifically mentioned this. 29% of PGs mentioned the client in some way (e.g. their expectations, perceptions about solutions) while only one UG (5%) mentioned the client in this way. On the other hand 33% of UGs considered having all their questions answered as a criterion for success (compared with 14% of PGs) and 36% of UGs mentioned getting the requirements (compared with 14% of PGs). Some students (10% of UGs and 29% of PGs) suggested that successful interviews would be determined by whether their suggested solution was accepted by the client (and in one case actually implemented) as the criterion for success. Overall, it would appear that postgraduates are more overtly interested understanding the problem, the current situation and showed some (small) interest in the client. Undergraduates as a group were more scattered in their responses to deciding what constituted success and were somewhat more concerned with having questions answered and getting the requirements.

*UG: 21 students*

Six students (29%) described success in terms whether they believed that they understood the problem and requirements. Seven students (33%) described a successful interview in terms of all their questions being answered with two others (10%) measuring success in terms of the extensiveness of the facts gathered. Two students (10%) deferred whether the decision as to whether the interview was a success until they had a chance to talk to the client to confirm their understanding. The most thoughtful answer covered understanding the problem, the gap between what is known and what needs to be known together the need to get feedback from client and supervisor. Two students suggested that the success would be based in whether their solution was chosen or successfully implemented.

*PG: 14 students*

Virtually all PGs mentioned or implied that understanding the problem or the problem description as a criterion for success and most (9 of 14) mentioned scope. 8 of 14 mentioned understanding the current situation or process. I relation to the client and other stakeholders, four students mentioned the client's expectations. Two students described being successful as either having all their questions answered or being able to control the questions. Four students interpreted success in terms of success of the project rather than the interview. One student suggested that all aspects of the project should have been determined before looking for solutions. Overall, the focus was on the problem description and relatively little on the client and overall context.

### Q2 Theme 3: Interview expectations

This was largely ignored by students.

### Q2 Other

Two students mentioned the need not to jump to conclusions with one stating the need to be holistic in thinking and the other the need to test assumptions.

## Question 3 Business problem and its importance

**Describe what you perceive to be the business problem and the vision of how things will be different assuming the problem is solved. To what extent do you believe that the project you are working on is realistic and of importance to the client? How relevant or interesting is the project to you?**

*The aim of this question was to see what students perceived as the business problem(s) and goal(s). Issues that were of interest were whether students differentiated between the business problems and goals as opposed to the IT problems and goals; they described superficial problems or look for more fundamental ones; or they are stating the problems or goals or describing solutions that might solve the problem or achieve the goal.*

### Q3 Theme 1: Business problem and goals

*Overall*

Students tended to describe the project in terms of solving a single problem or achieving a single goal however, they were differing views as to what was the problem or goal. The elimination or reduction of paper at meetings was mentioned by many (65% of UGs and 38% of PGs). Also often mentioned, in a varying ways, was a desire to improve the efficiency and effectiveness of the meeting process (27% of UGs and 46% of PGs). A few students mentioned both of these as problems needing to be solved

(14% of UGs and 15% of PGs). A few PG students (23%) described the problem or goal in terms of a specific IT solution, namely the need for some form of document management system. One UG student described the problem more generally as a lack of automation. Other problems mentioned by UG students were that the client didn't understand user requirements, that face to face meetings were being held (as opposed to some form of online system) and change management.

Most students did describe the problem/goal from the clients' perspective although a few focussed on an IT solution. Only around 15% of students mentioned that there were two problems/goals described by clients. As well, a few students mentioned different problems or goals. If we accept that it is extremely important to have a clear understanding of the problems and goals of the project then the great majority of students provided a rather superficial discussion of these problems and goals especially given the considerable amount of time provided for interviews.

*UG: 22*

Fifteen students (65%) stated that excessive paper consumption only as the business problem. Six students (27%) described the problem as an inefficient process in organising and conducting meetings. Two students (9%) believed that document management was the problem. Only three students (14%) described the situation as two or more problems which are interrelated i.e. excessive use of paper, desire for a more efficient process for organising and conducting meetings and document management. One suggestion was that the real problem was the use of face to face meetings for communication and conducting meetings. Other problems identified were lack of automation, the client didn't understand user requirements, face to face meetings and change management.

*PG: 13*

Two students (15%) did not address the problem. Five students (38%) mentioned elimination or reduction of paper as the problem, six (46%) mentioned improving the meeting process and of those only two students (15%) mentioned both as problems. Three students (23%) mentioned document management or the need for a document management system as the problem.

### Q3 Theme 2: Importance to the client

*Some students believe that the projects are contrived or trivial and the clients are, to an extent, role playing and as a result they approach it as simply an assignment or possibly* *feel that the project is of no value or importance. In fact, the very great majority of projects, while they may not be exactly "mission critical", can become of significant importance to the project clients if they are treated seriously and conducted in a professional manner. For this reason we encourage students to explore the reasons behind their projects.*

*Overall*

PGs and UGs were similar in their response to this theme. Overall, around one third of students in both groups did not address the issue of client motivation for the project. Four UGs thought that the project was of great importance to the client while one believed it was of low importance but these students did not state any particular underlying motivation. A few students (18% of UGs and 15% of PGS) mentioned conforming to the organisational goal of sustainability. Three PGs (23%) mentioned the improved meeting process as the motivation. Other reasons given were saving paper, saving time, money, greater efficiency and protecting the environment. Overall, responses here were consistent with the relative lack of interest in the client.

*UG: 22*

Seven UGs (33%) made no mention of this at all. Four students thought the problem was of "critical" importance while another thought it was low importance but none of these students indicated what motivated the clients. Four (18%) mentioned the motivation as conforming to the organisational goal of sustainability. Other reasons mentioned were saving time, money, greater efficiency and protecting the environment.

*PG: 13*

Four PG students (31%) did not mention this at all. Two (15%) mentioned conforming to organisational goals. Three (23%) mentioned the improved meeting process as the motivation. Other reasons given were saving paper, saving time, money, greater efficiency and protecting the environment.

### Q3 Theme 3: Goal/vision and Solutions

*The aim here was to see if students viewed the goal in terms of how the client would see it or in terms of the technology.*

*Overall*

On the whole students did describe the goal from the client's perspective.  This theme will be merged with theme 1 on business problems and goals since they are so closely linked i.e. problems can be recast as goals and vice versa. I certainly struggled to make any distinction myself and found myself virtually repeating my analysis from theme 1. The issue in this question is that students should be stating the problems or goals from the business perspective rather than describing solutions that might solve the problem or achieve the goal.

Five students did not address this issue. Four students stated in varying degrees that the goal was reduced use of paper with another student also suggesting fewer meetings. One student only mentioned the goal solely as an improved process. Six students stated that it was both the reduced use of paper and an improved process. Four students described the goal as the implementation of an electronic document repository. Finally, one student saw the goal as the replacement of face to face meetings with on-line meetings.

### Q3 Theme 4: Realism

*This was intended to see if students thought the project was contrived or of little significance to the client.* (21 responses)

*Overall*

73% of UGs addressed this theme compared to only 46% of PGs. 23% of UGs thought that the project was realistic because they believed that satisfactory solutions could be found; no PGs mentioned this. While 32% of UGs thought it was realistic because they perceived that clients were genuinely interested in solving the problem only one PG (8%) mentioned this. On the other hand 38% of PGs described the problem as realistic because they saw this problem as a common situation across other organisations while only 14% of UGs mentioned this. Overall PGs seemed less concerned about realism and, of those who mentioned it, they expressed it as realistic because it was a problem across many organisations. UGs on the other hand interpreted realistic to express explicitly their opinion that solutions could be found (with a couple expressing a little doubt in their skills) and appeared more concerned that the problem was of genuine interest to the clients.

*UG 22 students*

Six students (27%) did not address this issue. Fourteen students (67%) thought the project was realistic but had differing interpretations of the term realistic. Five students (23%) interpreted realistic to mean that it was likely that a satisfactory solution could be found or implemented. Seven students (32%) described the project as realistic because the client and stakeholders appeared to have a very real problem to be solved. Three students (14%) thought it was realistic because they were aware that was seen as a problem across other organisations. There were a few doubts expressed: one student thought multiple teams competing on the one project was unrealistic and two that expressed some doubt about their ability to find acceptable solutions.

*PG 13 students*
Seven students (54%) did not address this theme. Five students (38%) saw this as realistic because they were aware that was seen as a problem across other organisations and an implication that solutions existed. Only one student mentioned realistic to mean that the clients saw this as a real problem that they wanted to solve.

### Q3 Theme 5: Student motivation

*Overall*
73% of UG students and 69% of PG students addressed their own motivation. The most common reason given for interest in this particular project by UG student (ten students, 45%) was the potential application to other parts of the organisation or that it was a problem common to many other organisations. PG students (31%) most mentioned that it was real world application. The difference here could be explained by the fact that many of the UG students would have undertaken several months of work in the IT industry as part of their coursework and so were not so concerned real world application but rather its importance and broader application. Relatively few PG students have had experience in the IT industry and fewer still in an Australian context.

*UG: 22 students*
Five students did not address their own motivation. One student found the topic boring. However, 16 students (76%) described it as interesting or very interesting. The most common reason given with ten students (45%) was that they could see potential application to other parts of the organisation or to other organisations in the future. Some weak themes (two students) e.g. it was a real world problem, interest in environmental issues, relevance at their work place.

*PG: 13 students*
Four students (31%) did not address their own motivation. Four students (31%) found it interesting because it was a real world application. Thereafter there were some weak

themes (two students) e.g. application of previous studies, benefiting the client, it was a learning experience.
A few students criticised those being interviewed because they weren't able to sufficiently articulate the problem and goals and in a few cases also because they didn't know how to go about achieving the goals.

## Question 4 Control Strategies

**Control strategies are things you do that determine if you are on track and, if not, to diagnose what the problem might be and help you to get you back on track. What control strategies do you have in place to ensure that you understand the problem, have an appropriate scope and that requirements are correct, comprehensive and measurable?**
The question was aimed at determining how students ensured that the right problem was being solved.

### Overall

For both UGs and PGs only some mentioned client feedback as a control strategy for determining whether they understood the problem, scope and requirements with only 23% of UGs mentioning this and 18% of PGs. One marked difference between the groups was that 29% of PG students mentioned strategies related to recording and reviewing information from interviews and developing models as a control strategy whereas none of the UGs students mentioned this.  Another difference was weekly meetings with their supervisor with 36% of UGs mentioning this but only 6% of PGs. Regular (at least weekly) team meetings was the most often mentioned strategy (UGs 45% and PGs 56%). Reviewing each other's work was mentioned by 18% of UGs and 35% of PGs. If all strategies mentioned by students related to assisting in developing internal team agreement and consistency (e.g. weekly team meetings, reviewing each other's work, minutes and action plans, team document repository, good communication between team members) are combined then another marked difference is observed with 54% of UGs mentioning one or more of these strategies compared to 82% of PGs. Overall, we can characterise the results by saying that relatively few students mentioned getting client feedback as a strategy for determining if they understood the problem, scope and requirements. Even fewer mentioned strategies related to recording and reviewing information from interviews or developing models. Most students (particularly PG students) showed concern for internal agreement and consistency amongst their team members. UG students appeared considerably more reliant on their supervisor meetings than PG students.

UG:

The responses to this question varied considerably. Surprisingly, only 23% mentioned feedback from the client as a control strategy for determining whether they understood the problem and requirements. The strongest single control strategy mentioned by 45% of students was regular (at least weekly) team meetings. This was followed by 36% mentioning their supervisor meetings. 18% mentioned reviewing each other’s work. 18% of students thought that having a project plan was an appropriate control strategy while another. If all strategies mentioned by students related to assisting in developing internal team agreement and consistency (e.g. weekly team meetings, reviewing each other’s work, minutes and action plans, team document repository, good communication between team members) are combined then 12 students (54%) in aggregate mentioned. 18% of UGs mentioned the project plan a control strategy.

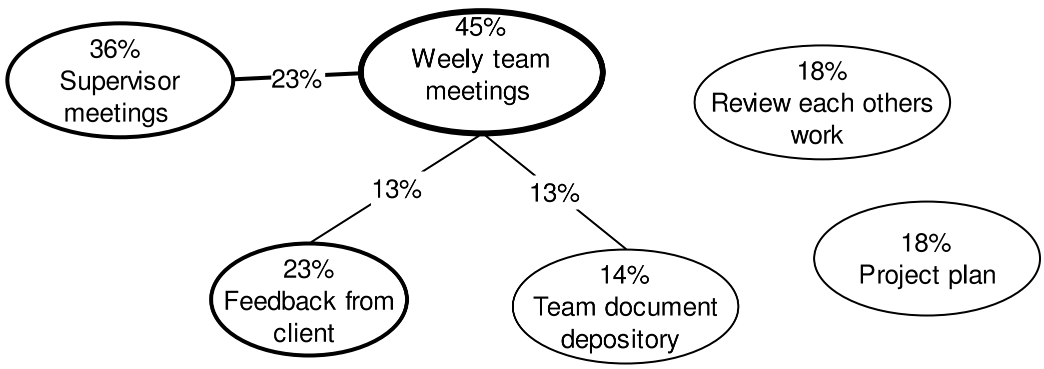


**Figure 4 Journal 1 Q4 UG**

PG:

Similar to the UGs only 18% of students mentioned feedback from the client as a control strategy. 65% mentioned regular (at least weekly meetings). 35% mentioned reviewing each others work. 41% mentioned having a project plan. If all strategies mentioned by students related to assisting in developing internal team agreement and consistency (e.g. weekly team meetings, reviewing each others work, minutes and action plans, team document repository, good communication between team members) are combined then 82% of students mentioned at least one strategy on those strategies.

Interestingly, 29% of PG students mentioned strategies related to recording and reviewing information from interviews and developing models as a control strategy. 41% of PG students mentioned having a project plan.

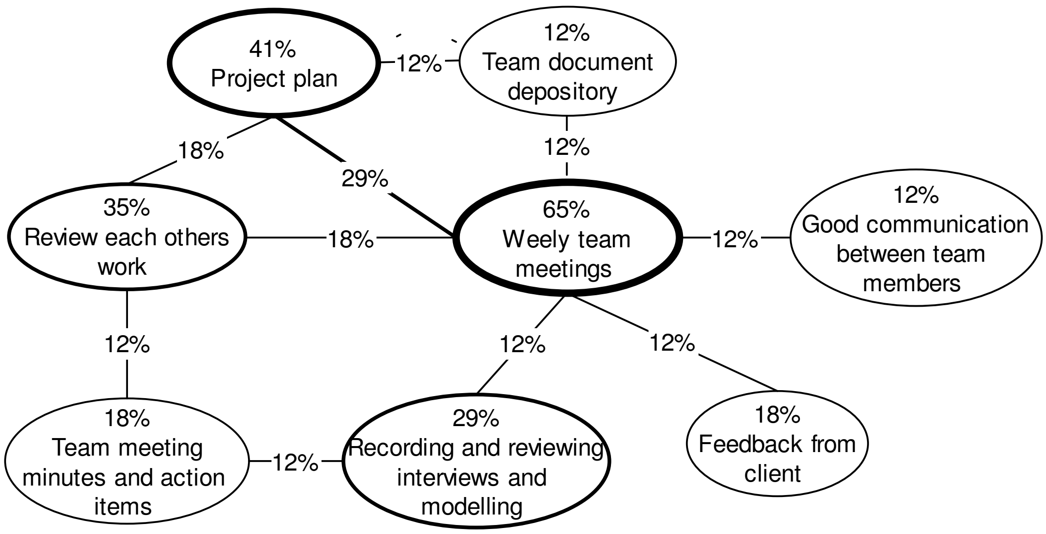


**Figure 5 Journal 1 Q4 PG**

## Question 5 Personality type and personal relevance

**Having done the Myer Briggs test what is your suggested personality type? Does it appear to be substantially correct for you? If not, where does it appear to be incorrect? Was it helpful to you in any way to do this test?**

### UG:

95% of UG students actually did the test but only 77% of students explicitly stated their MB personality type in their journal. 77% of UGs thought that their result was quite consistent with their own view of themselves (although not exactly the same set as the 77% who provided their MB type). 36% of students believed that doing the test was helpful in understanding themselves better, highlighting their strengths and weaknesses or with team dynamics. Overall, 32% of UGs explicitly expressed positive terms (such as "interesting", informative, helpful, happy etc.) to describe their experience in doing the test and interpreting the results. On the other hand 27% expressed some doubt about the reliability of the test or its repeatability but in some cases this appeared to be based on misunderstanding such as a "black or white" interpretation of the result for each preference pair so that scoring 55%-45% for a preference pair was seen as no different to scoring 100%-0%; one student (5%) suggested that it was obvious what the "correct" answers to the test were; and one student (5%) stated that the test was "*false and quite* *controversial*" because people change behaviour with the context. One particularly thoughtful response stated that they found their work stressful and having done the test realised that this was because their fundamental personality type was very much at odds with the personality type they needed to "adopt" to do their work.

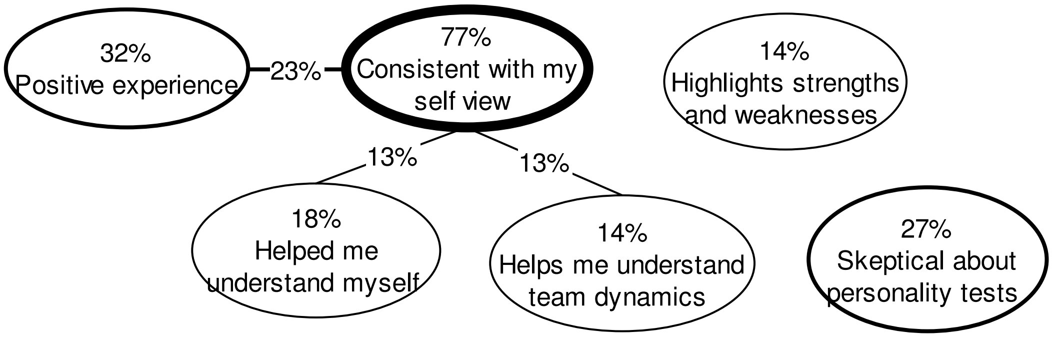


**Figure 6 Journal 1 Q5 UG**

PG:

All PG students did the test but only 88% of students explicitly stated their MB personality type in their journal. 71% of PGs stated the test was consistent with their view of themselves. The great majority of PG students (71%) used positive terms regarding their experience with doing the test with no responses which were negative or expressed doubts. 59% believed that the test had helped them understand themselves better or helped them understand their strengths and weaknesses. 24% thought the results potentially useful for improving team dynamics.

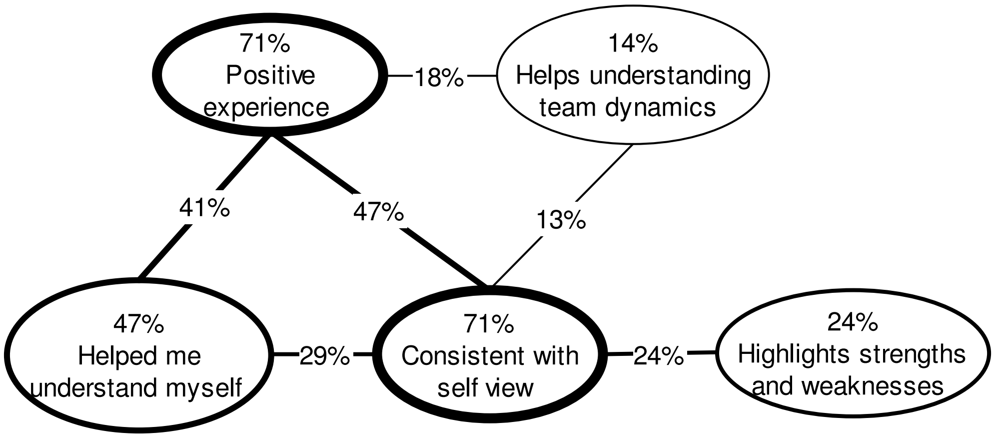


**Figure 7 Journal 1 Q5 PG**

## Question 6 Personality type comparison with team members

**Compare yourself with your team mates across the four dimensions of E/I, S/N, T/F and J/P. Describe the potential problems that might arise given your particular mix of personality types.**

### Overall

Many responses were vague and ill-informed but it was possible to squeeze a bit out if this by looking at the perspective of disagreement or conflict. Some students took the perspective that having differences across the various dimensions was a problem that needed "fixing". However, a more effective team will be made up of people who bring a balance from each of the Myer Briggs dimensions to the project and that disagreement can be very productive.

The application of the Myer Briggs test seems to have been useful for self-understanding and it made students aware of how other students might differ from them. When it came to team dynamics there were two different levels of understanding. The first was to see the differences in personality types could lead to disagreement or exclusion and this was a problem that needed to be dealt with. 82% of PGs demonstrated this understanding. The second level was to view the disagreement and conflict as potentially positive because it could provide a more holistic approach which might enhance project outcomes. 12% of PGs demonstrated this level of understanding. On the whole any attempt at more detailed analysis and discussion re MB types was exceedingly poor.

I think that some other approach for looking at team dynamics could prove more useful. One possibility is the Belbin model.

### UG: 22 students

14% of UG students gave no significant response to this question. 82% gave what could be described as a naïve analysis which was very superficial, concentrated on only one dimension (in 45% of UGs this was the Extravert/Introvert dimension) or showed very little or flawed understanding of the dimensions of the Myer Briggs personality type. Only one student (5%) actually compared the team members across each of the dimensions and analysed the potential advantages and disadvantages in each dimension. A strong theme with 50% of UGs was that they suggested that developing effective communication and involvement among team members was important in dealing with personality differences. 27% of UGs explicitly viewed the differences in personality types within teams as a problem to be solved (apparently treating it as conflict management) while only 14% described these differences as potentially positive because it provided different perspectives which could improve the project process and outcomes.

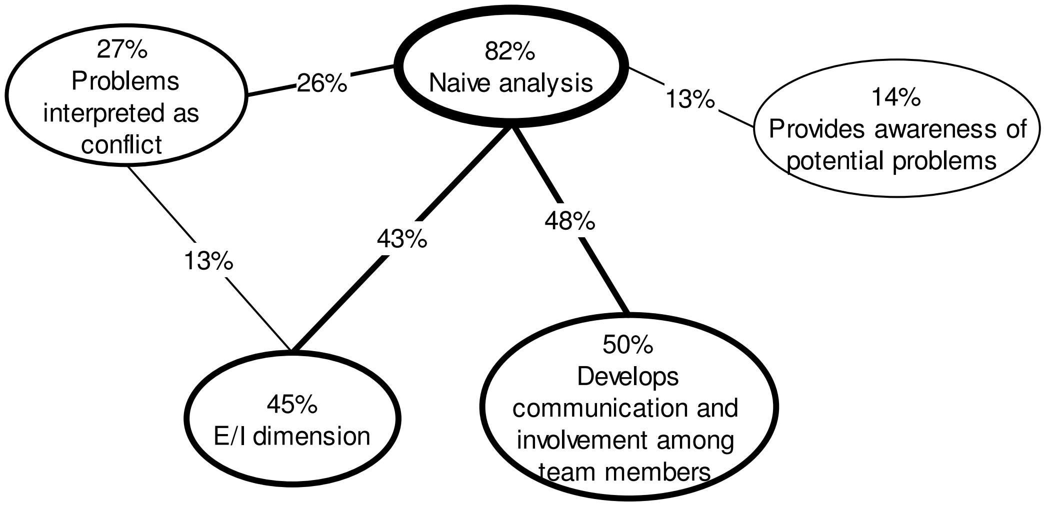


**Figure 8 Journal 1 Q6 UG**

PG: 17 students

One student (6%) gave no significant response. Similar the UG students, 82% of PGs gave naïve analyses while 12% provided a more sophisticated analysis across all the MB dimensions. 65% appeared to view the presence of personality differences a problem (of conflict management) with 18% of PGs suggesting that having most of the team members the same type as a good thing because there would be more harmony in the team. Only 12% saw the differences as potentially positive for the project.

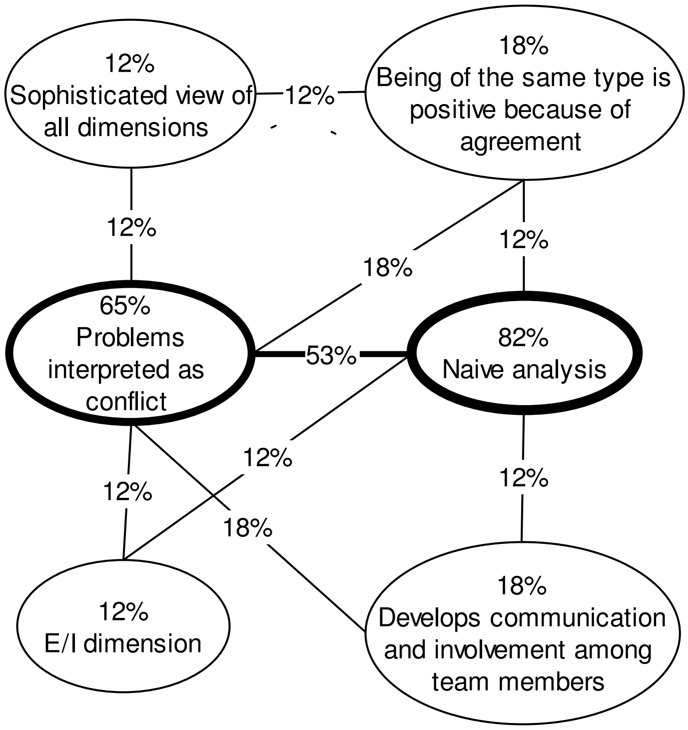


**Figure 9 Journal 1 Q6 PG**

## Question 7 Team Agreement and management

**Team members need to agree on the project goals, standards and generally about how the team members operate. To what extent do you believe that your team has this agreement? What management and control strategies does your team have in place to ensure that you will finish on time, that all members have share the workload fairly and that work is of an acceptable standard?**

### Overall

On the question of team agreement on standards and goals, students divided into roughly three groups with about 30% stating that they had explicit agreements in place, 30% stating they had implicit agreements (or so they believed) and 40% not indicating one or the other. Post graduates were more likely to have explicit agreements on goals and standards (one third) compared to undergraduates (one quarter). On the other hand more undergraduates believed they had implicit agreements (one third) compared to postgraduates ((one quarter). Many postgraduates (two thirds) suggested that discussion in team meeting would lead to shared goals and standards compared to undergraduates (one third). A greater proportion of undergraduates (one third) compared to postgraduates (one quarter) thought that peer review of their work among team members would maintain quality and standards of work. Other means mentioned of developing agreement were extensive use of email or a shared website. The fair sharing of work was mentioned by only 30% students overall but of these none described any explicit process of doing so with suggestions that the team (or team leader) would aim to share work fairly.

UG: 22 students

27% responded that that the team had some form of explicit agreement (either verbal or written) on goals and standards (e.g. of work, team operation, values). On the other hand, 32% of UGs responded that there was an implicit agreement among the team members. For example one student stated "I think we all have a mutual agreement and view that we are mature and responsible enough to fulfil these tasks at an acceptable standard." Another responded with "The agreement with our group is very simple. We have all have a very similar thought pattern and are willing to listen to each other's input."

36% of UG students mentioned that discussion and agreement in team meetings would address many of the questions. Others (23%) mentioned the extensive use of email or a shared website (23%).

36% of UGs mentioned that quality and standard of work would be maintained through the use of peer review of work submitted.

23% stated that sharing of workload was accomplished by team members actively working toward this goal. Another 9% mentioned that they had no process to share workload while 9% believed that the team contribution statements (a worklog) which were required to be submitted by each team would achieve this.

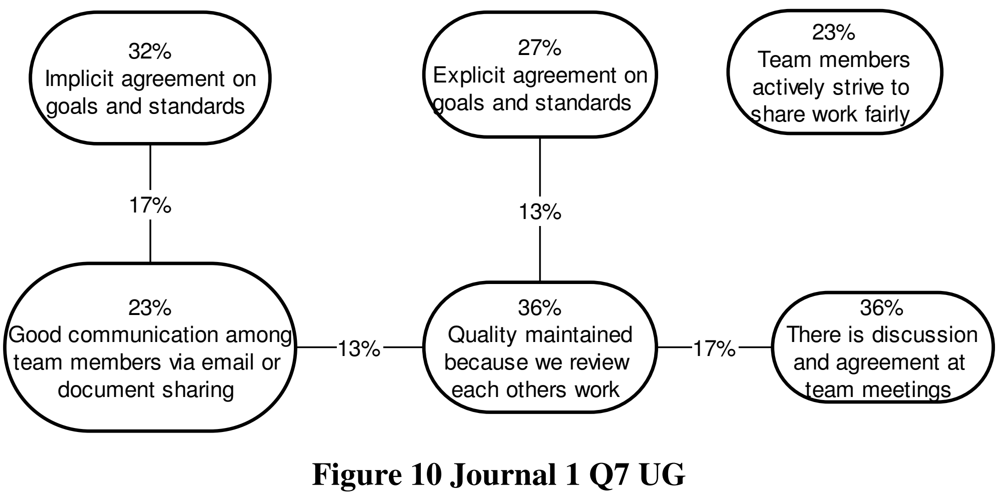


**Figure 10 Journal 1 Q7 UG**

PG: 17 students

35% of PGs stated that they had an explicit agreement on goals and standards while 29% believed they had an implicit agreement.

65% of PGs mentioned regular team meetings as the occasion for discussion and agreement. 18% of PGs mentioned email or a shared website.

29% of PGs expected peer review of each others work to maintain the quality and standard of work.

35% of PGs believed that team members would strive sharing work fairly.18% of PGs mentioned the team leader as instrumental in allocating work and maintaining standards.

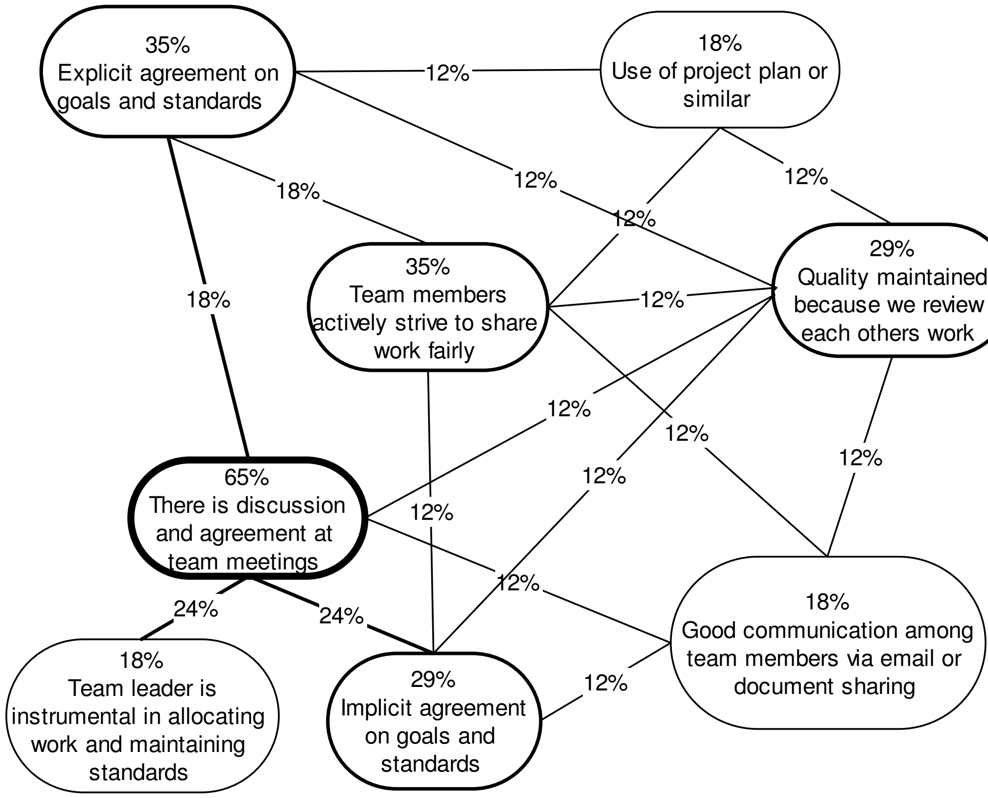


**Figure 11 Journal 1 Q7 PG**

## Question 8 Understanding the unit requirements

**By now you should have looked at some reports by previous project groups as well as other materials provided to assist you. You should have a reasonable idea as to what has to be done and standards to be achieved. How well do you believe you understand what you have to do in your project and the standards that will be**

**applied? If your understanding seems poor or mediocre then what is concerning you?**

Overall

The great majority of students (86% of UGs and 76% of PGs) believed that they understood the work that was required, standards to be achieved and had gained some guidance regarding the possible structure of their report. The discussion within the responses suggested that reviewing reports had alerted them about issues that they had hitherto neglected or to rethink the depth of research and analysis that was expected. A few students (14% UGs and 24% of PGs) either did not respond to this question; had not looked at the reports or appeared to misunderstand the question.

UG 22 students

Overall, 86% of UG students found reviewing previous reports helped them understand the work required, standards to be achieved and some guidance regarding the possible structure of their report. The discussion within the responses suggested that it had given some of them pause to think about issues that they had hitherto neglected or to rethink the depth of research and analysis that was expected. The other 14% of students either did not respond to this question; had not looked at the reports or appeared to misunderstand the question.

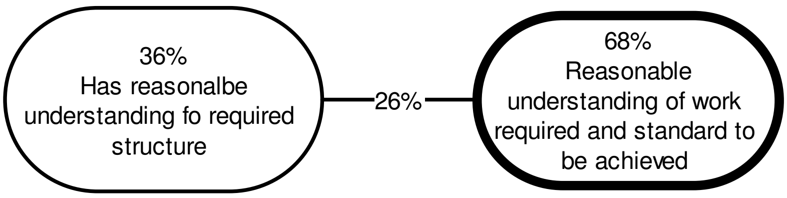


**Figure 12 Journal 1 Q8 UG**

PG: 17 students

76% of PGs responded that they believed they understood what had to be done and the required standard. 24% gave either no response or responses that did not appear to address the question.

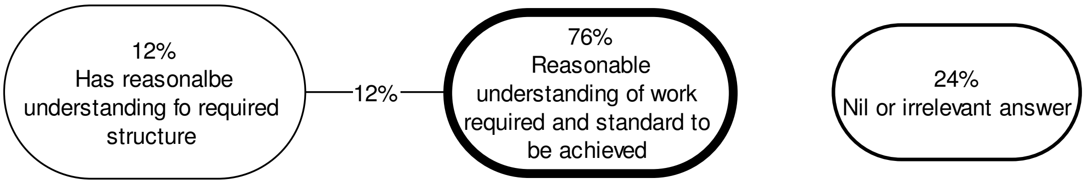


**Figure 13 Journal Q8 PG**

## Question 9 Learning form team mates

**Do you believe that you have learned something new or are learning anything significantly new from *your other team members*? What are these? These might be ideas or facts but they may also relate to attitudes, perspectives or ways of doing things related to communication, teamwork, leadership, organisational skills academic skills etc. Consider also that you might also be learning something by observing what appear to be others' mistakes, poor attitudes etc.**

### Overall

The great majority of students (64% UGs and 59% of PGs) stated that they had learned something about the process of working with their team members. On the positive side, some of the things learned were the importance of constant communication, flexibility and adaptability in dealing with others, how cooperation builds goodwill, enthusiasm encourages greater effort whereas on the negative side 5% of students had learned that some people are unreliable or have poor attitudes. 36% of UGs and 59% of PGs mentioned learning something from a single individual such as how to more effectively format documents, using a document sharing site more effectively for team collaboration, planning ahead so that things were not left to the last minute, observing and learning from another team member's confidence in expressing ideas. Finally, 18% of UGs thought they had learned nothing from fellow students while only 6% of PGs stated this.

### UG: 22 Students

36% stated that they had learned something specific skill or attitude from another student such as how to effectively use a document sharing website for team collaboration, the value of planning ahead and not leaving things to the last minute, being more confident in expressing ideas, using MS word more effectively for formatting documents etc. 64% of UGs answered this question from the perspective that they had learned something about the process of working with other students.

Examples are the need for constant communication, how cooperation can spread goodwill amongst the team, the value of holistic understanding of the project for all team members, the value of different perspectives, being flexible and on a negative note that many people are unreliable. On the other hand 18% of UGs stated that they had not learned anything.

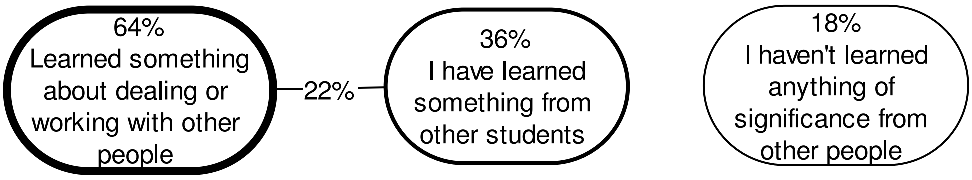


**Figure 14 Journal 1 Q9 UG**

PG: 17 students

59% of PGs believed that they had learned something specific skill or attitude from another student. 59% answered this question from the perspective that they had learned something about the process of working with other students. Examples were the need for good communication, being aware of cultural and social boundaries, dealing with different working styles, an enthusiastic team encourages extra effort, and on a negative note that some people have poor attitudes.

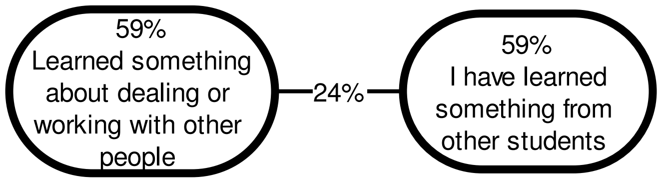


**Figure 15 Journal 1 Q9 PG**

## Question 10 Supervisor meetings

**The meetings held each week with your academic supervisor and fellow team members are intended to encourage discussion to clarify ideas, highlight problems, suggest problem solving strategies and generally share ideas and viewpoints between the team members as well with the supervisor. What have been the most important outcomes from these discussions for you since the last journal?**

### Overall

Nearly all students (86% of UGs and 100% of PGs) responded that they found the supervisor meetings useful. Of the remaining 14% of UGs one (5%) had not attended any meetings and the other two (8%) discussed an issue of a supervisor needing to intervene in a change of the team leader. The most dominant theme by UGs (82%) and PGs (88%) was that they appreciated their supervisor's feedback. Responses from students mentioned being able to "bounce ideas off him", the supervisor asking probing questions, providing guidance on areas they should be investigating, what to focus on, helping them clarify the problem or scope, looking at the "big picture" as well as details and thinking more broadly on the solution options. Supervisor meetings also helped to keep teams "on track" (41% UGs and 24% PGs). "On track" was a term used by many students and which I am interpreting to mean working on the right tasks in an appropriate manner and at an appropriate pace to finish the project successfully. Even teams that were already "on track" appreciated their supervisor's acknowledgement of this and this appeared to give them confidence and motivation. A couple of comments by PG students are worth mentioning. One was that the supervisor meetings provided an occasion when team member contributions were acknowledged and encouragement given and another that these meetings improved the student's ability to participate and to share his ideas.

UG:

86% of UGs stated that they found the supervisor meetings useful. 82% mentioned that the supervisor provided useful feedback mentioning things like being able to "bounce ideas off him", guidance on areas they should be investigating, what to focus on, clarifying the problem or scope, looking at the big picture rather then focussing on details etc. 41% mentioned that they kept the team on track or confirmed that the team was on track (not necessarily citing any specific example). A feeling of being on track appeared to give confidence and motivation that they were going to achieve their goal (successful completion of their project) although they may not have seen this clearly themselves. 14% of UGs mentioned that the supervisor had asked probing questions that developed ideas. 18% of students mentioned that the supervisor had intervened into the team dynamics which had become dysfunctional and which lead to the change of team leader. No students stated that they found the supervisor meeting unhelpful or a waste of time. Two students (9%) concentrated on the change of leadership issue while the third student (5%) had been ill and had not attended the meetings.

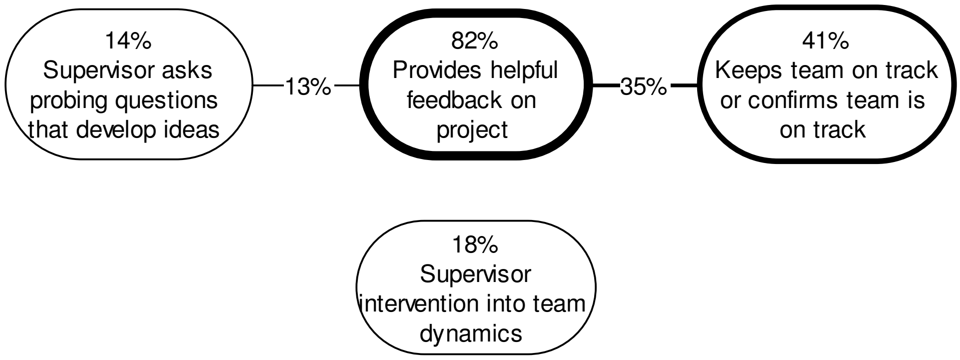


**Figure 16 Journal 1 Q10 UG**

## PGs

100% of PGs stated that they found the supervisor meetings helpful. 88% mentioned helpful feedback such as suggesting that the team was focus on the business aspects of project and not just the technical aspects, encouraging broader understanding of the problem context, broadening their view about potential solutions amongst others. 24% mentioned that they kept the team on track or confirmed that the team was on track. For one student the supervisor meetings provided an occasion when team member contributions were acknowledged and encouragement was given and for another thought that they improved the student's ability to participate and to share his ideas.

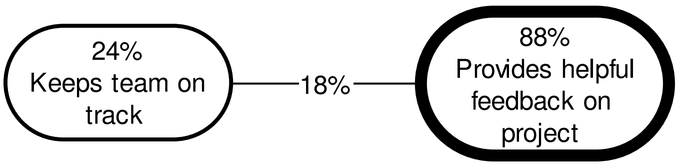


**Figure 17 Journal 1 Q10 PG**

## Question 11 Supervisor support outside meetings

**Are there any tasks or issues that your supervisor assisted you with outside the weekly discussions? If so what were they? Would you still need assistance if the same task was required in future or do you believe you could handle it okay by yourself (you alone or with your team members).**

*This is a cognitive apprenticeship question relating to finding gaps weaknesses in the teaching approach.*

There was nothing of significance here. The few comments that came through here were the same or related to the previous question so I went back and added the comments back into Question 10. I will drop this question in future journals.

## Question 12 Unit improvements

**Is there anything that you believe could have been improved up to this point or could still be improved for the remainder of the semester?**

The only theme here related to client interviewing which was very specific to the way in which multiple groups worked on the same project for that particular semester. There were single responses. Some that I will take up are: journals were too long which I agree with and so I am reducing them in future semesters, and that we need better document sharing between the supervisor and teams. Ones I won't are: doing a review of previous student projects – no time; and that supervisor should be at the client meeting which indicates that the student misses the point that it is the team's project and team's responsibility.

## Question 13 Other thoughts

**Any other thoughts?**

Nothing significant from undergraduates or postgraduates

# Journal 2 Analysis

## Questions 1 & 2 Change in understanding of problem or scope

*The responses to these sets of questions were combined since the responses appeared to overlap or were to some extent redundant.*

**Q1. Describe the and extent of your communications with your client organisation since your last journal. In what way(s) have they been productive? If not, what do you see as the problem(s)?**

**Q.2 Has there been any significant change in your understanding of the client's problem description and requirements in your project? If there have been significant changes what do you attribute this to? If there have been significant changes, with hindsight do you believe that you could have better determined these requirements at the beginning or not? If so, how? If not why not?**

*Q1 is a judgement question relating to client communication. Q2 is a judgement question relating to their understanding of the problem and requirements. If the problem definition or requirements have been changing, possible causes might be the team not have done a satisfactory job in eliciting requirements or the discussions with the client have clarified or changed their initial ideas.*

### Overall:

75% of UGs and 92% of PGs responded that further meetings with the client and other stakeholders had clarified their overall understanding of the project and/or helped them to further develop the requirements. For most students the broad scope was maintained but the granularity of detail improved. Interestingly, 15% of PGs mentioned that they had initially misunderstood the requirements and subsequent interviews corrected this; these students prematurely assumed a type of solution (a document management system) rather than ensuring that they had understood the client's problem description (a perceived need to improve the management, administration and productivity of meetings). In contrast 15% of UGs stated that the further interviews made no significant difference to their understanding or requirements. Another point of contrast between UGs and PGs was that no PGs expressed a desire for more meeting time with clients or other stakeholders, 30% of UGs expressed this desire for more time although one of these students also admitted that his workplace experience was that clients were "rarely" available for long periods of time.

The area that in which both UG and PG students mentioned difficulty was in relation to determining the problem scope. For example “the team have gone a bit side track in terms on the requirements of the project. This is a big issue as we might deliver a wrong solution to the client as what we propose are not what the client have requested”. And following on from this, "we came up with features which were out of scope." Another student found that their scope had focussed too narrowly and then found that “we had to look a bit more deep[ly] into all the other concerns”.

With regard to interviews one PG student realised that interviews required more planning and forethought than they had anticipated, "we didn’t explore how to get most of these meetings" while another seemed surprised how much information could be provided in an interview "… the conversation[s] were quite informative. It seems that notes taking are quite important. To some questions, I just could not put all the answers on paper. "

UGs (30%) expressed more critical comments about their client than PGs (8%). A common theme was to shift the burden of defining the problem, scope and requirements onto the client. Some examples include the following: "the requirements from the client should have been documented from the beginning to ensure groups are on the right track" and "If the client had been more specific (& less general; in terms of requirements) from the initial interview – then the problem understanding might have been made clearer earlier”. One student suggested that the clients would be inflexible in their attitudes, "the clients seem to be looking for a technology fix without the need to change their behaviour and ideas".

For some students it was while researching potential solutions that a difference or change in perception of the problem or scope became apparent. This might be because of misunderstanding by the team or changing understanding on the client’s part. For example, “The meeting with Business Analysts also helped us to think in the way what exactly they are expecting the system from us. It is been productive we have changed the way we were working by widening the search of solutions”. On the other hand a perceptive comment by one PG student was the following, "it is evident the client now a better grasp on their concept then when then project was first introduced. Due to my lack of experience I am unsure to state this is common or not in projects. However, I assume that the client understanding of the knowledge area would deepen over the course of any project”. Another student mentioned this evolution as a surprise, “To our surprise the clients requirements had changed a bit and this meant that we had to redo a lot of our work. The constant meeting with the client was very important as we saw a different side of the project and made the team realize that we had to revisit the client after achieving the major milestones.”

UG: 20 Students

75% of UGs responded that the further meetings with clients and stakeholders had clarified their overall understanding of the project and/or helped them to further develop the requirements. For most students the broad scope was maintained but the granularity of detail improved. On the other hand 15% stated that the further interviews made no significant difference in this regard. One student stated "communications with the client have been strong, but largely unproductive since gathering initial requirements and confirming our direction" while another suggested that only another stakeholder with a completely different perspective (IT infrastructure) made any difference and that only to the solution space. The area that in which students mentioned difficulty was in relation to determining the problem scope. and (particularly because there were multiple stakeholders expressing requirements ). 30% of students expressed a desire for more time with clients and other stakeholders although one of these students also admitted that his workplace experience was that clients were "rarely" available for long periods of time.

There was a broad theme for 30% of UGs which could be summed up as "the client is a problem". Some examples include the following:

"the requirements from the client should have been documented from the beginning to ensure groups are on the right track" and "If the client had been more specific (& less general; in terms of requirements) from the initial interview – then the problem understanding might have been made clearer earlier." i.e. it's not my responsibilty to determine requirements; the client should have known and told us precisely what is needed "the clients seem to be looking for a technology fix without the need to change their behaviour and ideas" i.e. it shouldn't be our job to tell them about the change management issues involved in adopting new technology

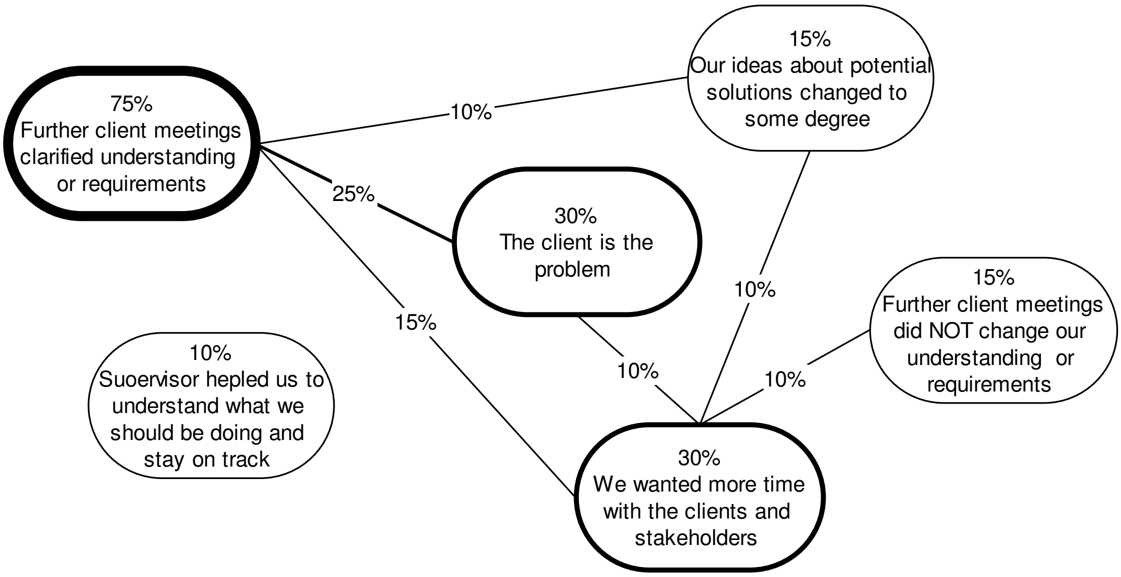


**Figure 18 Journal 2 Q1&2 UG Threshold 10%**

PG: 13 students

92% of PGs responded that further meetings with the client and other stakeholders had clarified their overall understanding of the project and/or helped them to further develop the requirements. Interestingly, 15% of PGs mentioned that they had initially misunderstood the requirements and subsequent interviews corrected this, however, what these students described as a requirement related to a type of solution.

None of the PG students expressed a desire for more time with the clients.

Only one student (8%) mentioned the client "as the problem" and this was in regard to the inability of the client in the initial interviews to correctly categorise the requirements as "mandatory","critical" or "nice to have".

There were some interesting and perceptive comments by some PG students:

"it is evident the client now a better grasp on their concept then when then project was first introduced. Due to my lack of experience I am unsure to state this is common or not in projects. However, I assume that the client understanding of the knowledge area would deepen over the course of any project. "

Another student realised that interviews required planning and forethought "we didn't explore how to get most of these meetings" while another noted that "It seems that notes taking are quite important. To some questions, I just could not put all the answers on paper."

As to requirements and scope "we came up with features which were out of scope."

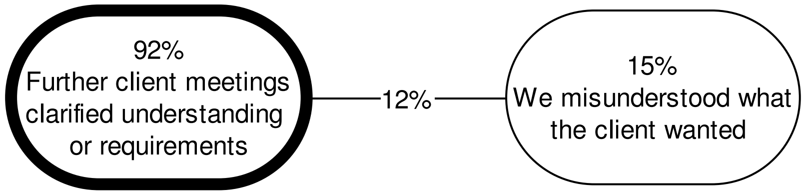


**Figure 19 Journal 2 Q1&2 PG threshold 10%**

## Question.3 Control strategies for finding solutions

**Control strategies are things you do that determine if you are on track and, if not, diagnose what the problem might be and helping to get you back on track. At this stage, these will relate to researching for possible solutions and finding the most satisfactory solutions which meeting the requirements and hence to solving the problem. What control strategies do you have in place to ensure that your research and finding solutions will be satisfactory?**

*This is a cognitive apprenticeship question but also a judgement questions relating to management and control of the task.*

## Overall:

There was a range of responses here ranging from strategies which were clearly targeted to finding the best solution to strategies related to project or team management. Both UGs and PGs suggested an average of around 2 strategies each.

By far the most cited strategy by 50% of UG students and 62% of PGs was finding and short listing solutions or recommendations based on the client's set of requirements as their control strategy. 15% of PGs (no UGs) mentioned mapping interview notes to requirements. Students also mentioned other strategies.

50% of UGs and 15% of PGs mentioned their team meetings, minutes and/or action plans. 30% of UGs and 23% of PGs mentioned adhering to a project plan as their control strategy although they may have been confusing a strategy for keeping the project on schedule rather than looking for solutions.

A strategy mentioned which may have been useful with regard to the research and solutions mentioned by 20% of UGs and 9% of PGs was peer review to ensure that quality was maintained or as a forum for critiquing research, solutions or recommendations. As one student put it, "*Peer reviewing all research is the main way this is done within my group. Since all researched information regarding solutions is reviewed by at least one other person, we know the work is of substantial quality. This is similar to the principle of "paired programming" applied in computer science*".

Supervisor meetings were mentioned by 20% of UGs and 18% of PGs.
The role of the supervisor emerged in the answers to these set of questions. There can be a fine line between supervisors supporting the team as opposed to controlling the team. For example this response, "*One of the main controls for the group to stay on track is the weekly progress meetings with [expert P]. Throughout the week, we were able to gain feedback on our progress, ideas and completed tasks*." suggests a supportive role. However, one PG student wrote, "*We used our supervisor as our control administrator, we shown him our work weekly and asked him to validate … I personally feel that we didn't get enough control from the supervisor*" which suggests that the project belongs or should belong to the supervisor and not the team.

## UG: 20 students

50% of students mentioned their regular team meetings as a control strategy with some suggesting that this helped to make sure that team members were doing the right things and staying focussed. 30% of students mentioned sticking to the project plan as a control strategy and most of these students also mentioned their regular team meetings. One student described these as a combination of long and short term strategies, "*The group constantly updates a Project Plan which outlines critical dates for tasks/activities that are due. Long term, the Project Plan helps group members focus on areas that are due, keeping in mind important dates. Each week the group drafts up action items in meetings held. The actions are short term and assists members to focus on weekly tasks.*" 20% mentioned regular meetings with their supervisor – two comments indicate that in some cases supervisor support was critical: one student found their supervisor "a huge help in terms of ensuring that we are on track and giving us direction when we do go off-course" and in another case "*we were struggling for a few weeks and we needed to have a harsh talking to, which ended up getting us back on track*".
50% of UG students suggested finding and short listing solutions or recommendations based on the client's set of prioritized requirements. Assuming the requirements are complete and comprehensive this is a useful control strategy.
20% of students mentioned peer review of work.

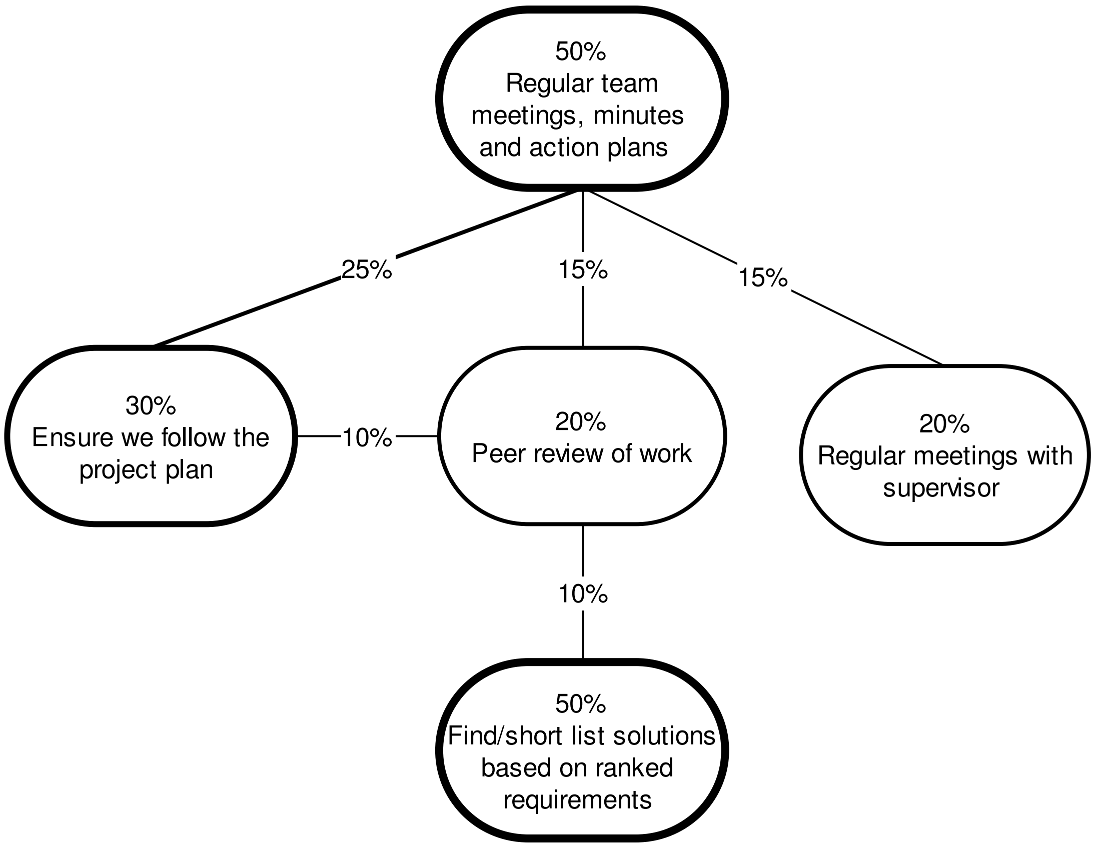


**Figure 20 Journal 2 Q3 UG**

PG: 17 students

62% of PGs discussed finding solutions or recommendations using the requirements document. 15% of PG students mentioned the mapping of interview notes to requirements as a control strategy and these also mentioned finding solutions using the requirements document. Also mentioned were regular team meetings (15%), following the project plan (23%) as control strategies and meetings with their supervisor (15%) as their control strategies. One PG student saw the supervisor meetings as essential, "*We used our supervisor as our control administrator, we shown him our work weekly and asked him to validate*". Possibly he misunderstood the role of the supervisor which was evidenced by a later comment "*I personally feel that we didn't get enough control from the supervisor*".

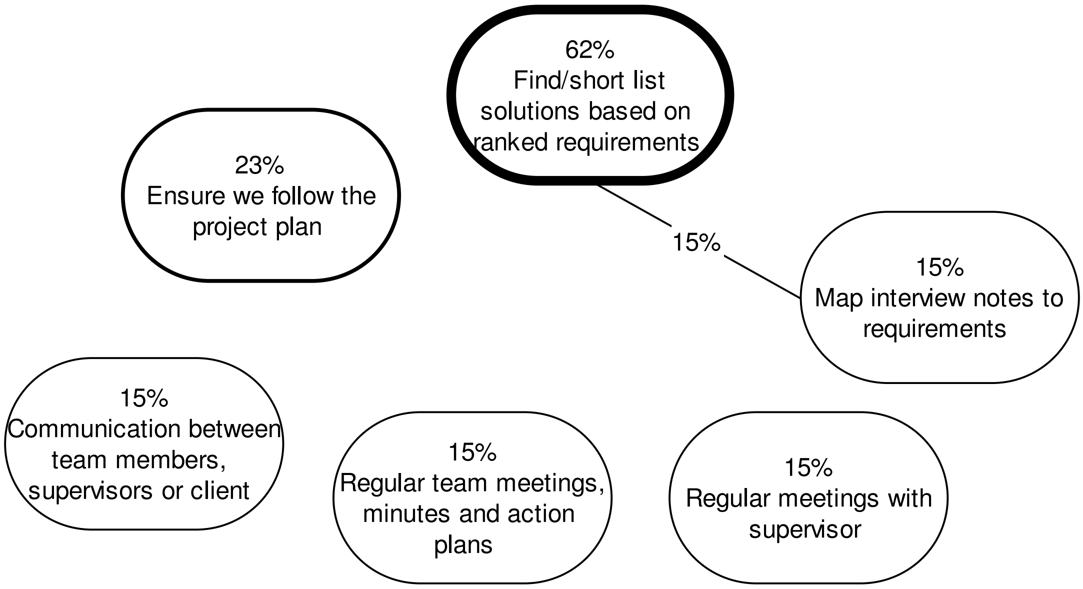


**Figure 21 Journal 2 Q3 UG**

## Question 4 Meeting objectives, managing workload and standards

**How well are your management and control strategies working to ensure that you will finish on time, that all members have fairly shared the workload and that work is of an acceptable standard?**

*This is a cognitive apprenticeship question but also a judgement question relating to management and control of people.*

### Overall:

30% of undergraduates stated that they had adequate control strategies but with little or no elaboration. Most of these students believed their progress was satisfactory hence their M&C strategies must be satisfactory, for example, "Our management and control strategies are working very well, as evidenced by our outstanding results for our tasks to date". With regard to the sharing of work 50% of undergraduate students responded that work was equally shared among the team members, however this division of work appeared to be on an ad hoc basis based on perception and trust rather than on a quantitative basis. Some of the control strategies mentioned by undergraduate students were having meetings together with keeping minutes and action plans (40%), having a good means of communication among the members outside meetings (15%), having a peer review process in place (15%), having well-defined team roles in place (15%) and following the project plan (15%). 38% of postgraduates mentioned that work was shared equally but on the whole postgraduates seemed less concerned about this issue. In terms of management and control strategies postgraduate students placed more emphasis on following the project plan (38%) and on the peer review process (46%). Other strategies were similar to undergraduates e.g. meetings with meeting minutes and action plans (23%), and having a good means of communication amongst the members outside meetings (15%).

### UG: 20 students

With regard to fair sharing of work, 50% of students responded that work was equally shared among team members, however this division of work appeared to be on an ad hoc basis based on perception and trust. 30% of students mentioned that their management and control strategies were working satisfactorily but with little or no elaboration. Most of these students believed their progress was satisfactory hence their M&C strategies must be satisfactory. 40% of students responded that they believed that their meeting processes and action plans were keeping team members on track and focussed. Successful strategies that students believed they had included adherence to their project plan (15%), well defined roles for team members based on their skill sets (15%), a peer review process for work produced (15%) and good communication among team members e.g. via email or common document repository (15%).

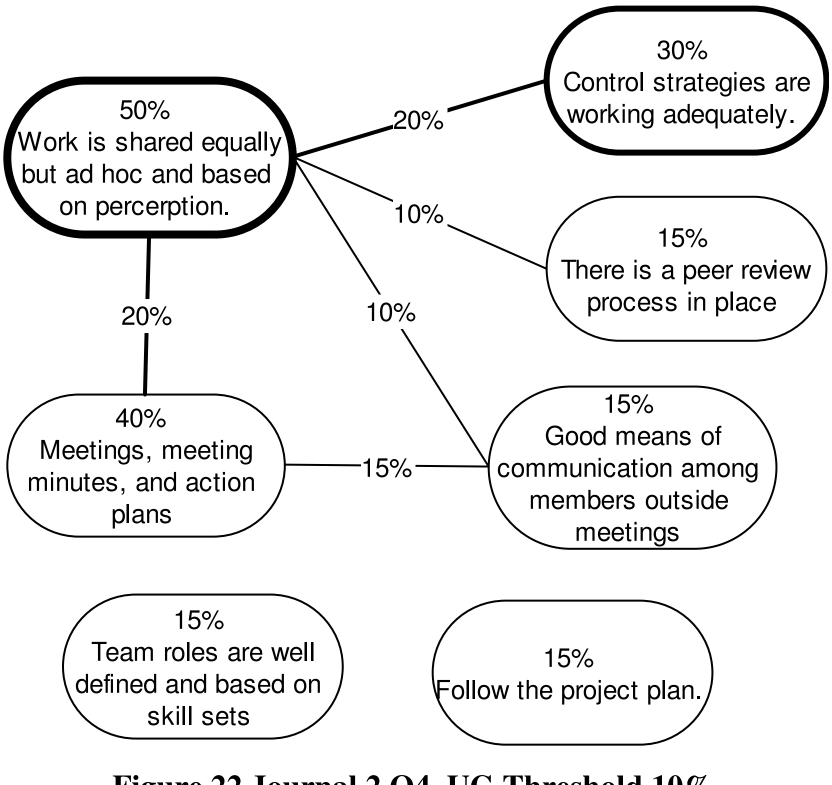


**Figure 22 Journal 2 Q4 UG Threshold 10%**

## PG: 13 students

The responses in this group were more broadly scattered. With regard to finishing on time 38% mentioned adherence to the project plan and only 23% mentioned the meetings and action plans specifically as means of keeping team members on track and keeping focussed. With regard to standards there was a strong theme related to peer review (46%). With regard to sharing of workload, 38% mentioned that work was shared equally but on the whole PGs seemed less concerned about this issue.

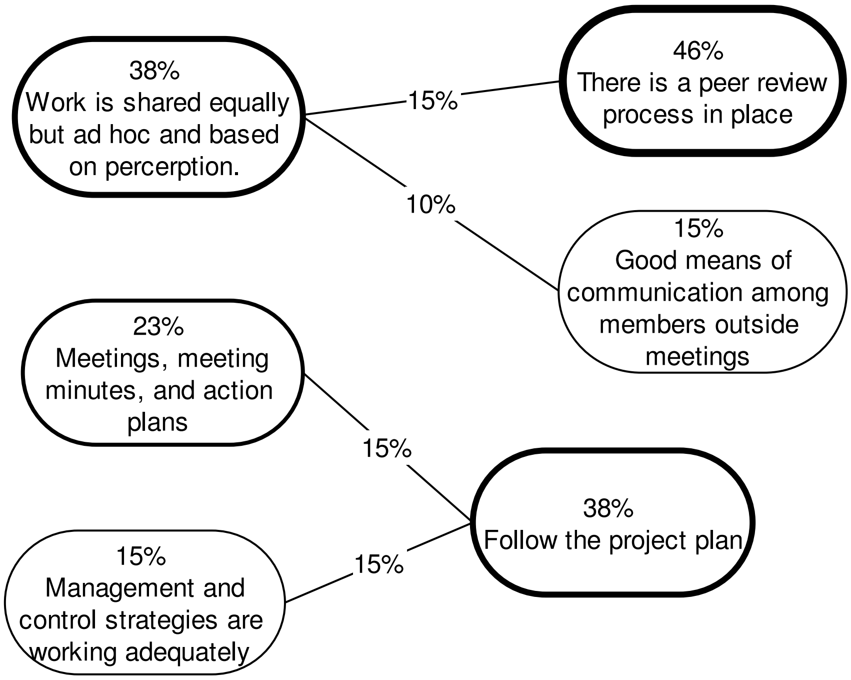


**Figure 23 Journal 2 Q4 PG Threshold 10%**

## Question 5 Team interaction

**How would you judge the team interaction at this stage? Whether it is good, bad or indifferent why do think it is going this way? Can you relate this to the interaction of your different personality types (from the Myer Briggs test) or something related to the small group communications work covered earlier this semester or something else?**

*This is a cognitive apprenticeship question relating to cooperation.*

## Overall

The great majority of students did make reasonable attempts at trying to describe the team dynamics but not many tried to do it by using the Myer Briggs personality types and those that did tended to focus on the introvert/extravert dimension to the exclusion of other dimensions. The clumsy and inconsistent manner of the responses suggests that either that MB should be addressed more deeply especially in dealing with interactions between different personality types or that another approach be adopted. My feeling is that MB is useful for analysing one's own personality and possibly matching it to roles but that it is difficult to apply for the purpose of understanding team dynamics; it also doesn't provide clear guidance in terms of how to progress a project to a successful conclusion. Approaches specifically designed to understanding small group dynamics and projects that I have examined appear to be easier to understand and apply and could be more productive.

### UG: 20 students

80% of UGs thought their team was functioning well. However, 15% rated their team interaction as "*indifferent*" or "*fairly frustrating*". Although one might suspect that all these negative comments emanated from members of the same team this was not the case so there appear to be contradictory viewpoints about the team dynamics. 15% thought that the team worked well together because they had similar personalties but as before these students were not all from the same team. 20% of UGs thought that understanding differences in personality had helped to improve the team dynamics. Two relevant quotes were "*Having a tolerance for our differences and an understanding of them helps smooth out the way our team interacts* "and "*the team interaction is rather strong and I believe that this has been able to be achieved by better understanding each other's personality type*".

### PG: 13 students

All students responded that their team was functionally reasonably well. Terms used by students varied in degree from "*really excellent*" and "*exciting in some ways*" down to "*good enough*". 23% of PGs thought that the diversity of personality types had been positive for the group either in terms of its dynamics (combining action and thought) or through constructive arguments that helped the quality of analysis and solutions; on the other hand a different 15% thought that personality differences made decision making more time consuming but didn't indicate whether this was positive or negative for the team.

## Question 6 Personal contribution to team

**What do you perceive as being your major contribution(s) to your team and (hopefully) the success of your project so far (for example, attention to detail, creativity, organisational skills, leadership, communication skills etc)? Is there anything (a role or task) that you wish you could do better?**

*This is a judgment question relating to self-awareness.*

### Overall:

Few strong themes emerged from this question. 46% of PGs suggested that attention to detail as their contribution while only 25% of UGs mentioned this theme. 38% of PGs mentioned leadership compared to 30% of UGs and in the great majority of cases these were the appointed team leaders. 30% of UG and 23% of PGs mentioned what I describe as team building and interpersonal skills characterised by comments such as the student doing “a lot of thinking before doing the task clarifying among members and getting everyone’s approval before going ahead” or that “I’m more concerned that if we are on the right track and if we are working towards the same goal” amongst others. 31% of PGs and 25% of UGs mentioned their organisational skills as a contribution. Other contributions mentioned by both UGs and PGs were communication skills (writing, speaking), management and planning, and creative thinking. Both PGs and UGs were reticent in suggesting areas for improvement but for UGs it was a need for more assertiveness (15%) and leadership (10%) while PGs mentioned leadership (23%).

### UG: 17 students

Answers varied widely for this question. 30% of UGs mentioned either directly or indirectly their team building and interpersonal skills as a contribution. While the term “teamwork” might have been explicitly mentioned as a response, examples of indirect statements which were categorised as team building interpersonal skills work were comments such the student doing “a lot of thinking before doing the task clarifying among members and getting everyone’s approval before going ahead” or that “I’m more concerned that if we are on the right track and if we are working towards the same goal” amongst others. 30% also mentioned leadership as a contribution and in the great majority of cases these were the appointed team leaders. Other responses mentioned were organisational skills (25%), attention to detail (25%), communication skills (20%), commitment (15%), analysis skills (15%), management and planning (10%) and creative thinking (10%).

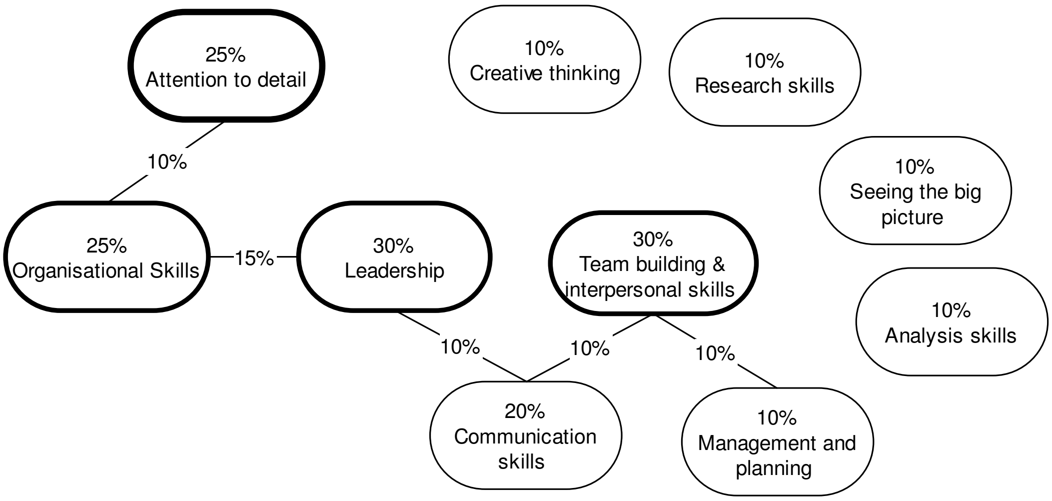


**Figure 24 Journal 2 Q6 UG threshold 10%**

PG: 13 students

46% of PGs mentioned attention to detail as one of their contributions to their team; included in this theme were comments related to reviewing other team members' work which I considered as requiring some attention to detail. While 38% of PGs mentioned leadership as a contribution, in most cases students were simply content to mention it without elaboration. 31% of PGs mentioned their organisational skills. Team building communication interpersonal skills were mentioned (31%) with students stating that they made efforts to encourage other team members, to build consensus, responding promptly to communications. Also mentioned were management and planning (23%) and creative thinking (23%).

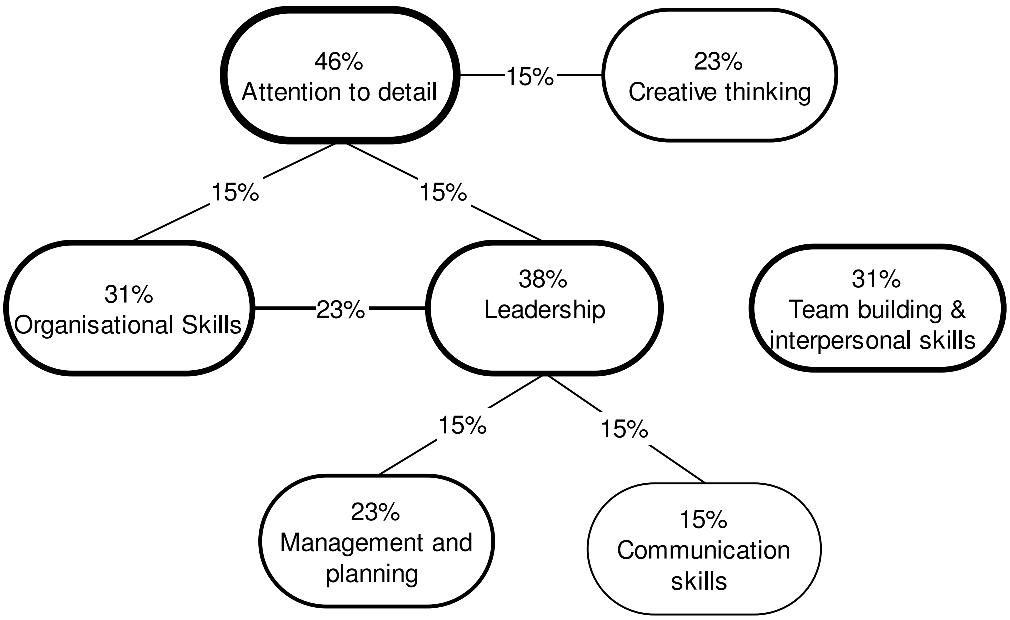


**Figure 25 Journal 2 Q6 PG threshold 10%**

## Question 7 Learning from tem members

**Since your last journal submission, do you believe that you have learned something new or are learning anything significantly new from your other team members? What are these? These might be ideas or facts but they may also relate to attitudes, perspectives or ways of doing things related to communication, teamwork, leadership, organisational skills etc. Consider also that you might also be learning something by observing what appear to be others' mistakes, poor attitudes etc.**

*This is a cognitive apprenticeship question relating to modelling and also cooperation.*

### Overall

PG students had fewer but stronger themes compared to UGs on team work related issues. PGs demonstrated more concern compared to UGs with the of working as a team rather than individuals, about quality of leadership and that team members were cooperating toward achievement toward a shared goals. On the other hand, UGs expressed more concern with trying to ensure that communication took place, how it was achieved and that it was positive in nature rather than negative.

The strongest theme by PGs was team management and leadership (46%) while only 20% of UGs mentioned this theme. PGs described the value of defined roles for members, being organised and focussed while others described the need for flexibility. On the other hand UGs described how they were learning how to gain cooperation from team members or were simply impressed by the leadership skills shown by their team leader.

38% of PGs and 35% of UGs mentioned effective communication but the emphases were somewhat different; PGs expressed more concern with overcoming shyness or fear in expressing ideas and then to do so clearly while UGs were more concerned with communication to keep each other informed, listening to the ideas of others and communicating in a manner to engage others and not alienating them. Both PGs (15%) and UGs (25%) appreciated the different perspectives and approach that other team members provided.

Themes mentioned by PGs which were not mentioned by UGs were supporting team members (15%) and working towards team goals (15%).

In terms of individual development themes undergraduate students mentioned learning to improve their personal productivity (20%) by observing how others were better organised and finished work ahead of time. Similarly 31% of postgraduate described getting ideas about improving their own personal productivity through observing other students' techniques for researching, reading and task management. Differences between postgraduates and undergraduates responses were that postgraduates mentioned critical thinking issues (23%) related to problem solving techniques and just thinking through things before acting whereas undergraduates mentioned motivation (10%) and a positive attitude (20%) with some impressed by the positive motivation toward work shown by some team members and disappointed by the lack of motivation in others.

UG: 20 students

There were a great variety of themes mentioned by UGs which can be broadly categorized into individual development themes and team work based themes. In the individual development themes students mentioned learning to improve their personal productivity (20%) by observing how others were better organised and finished work ahead of time. Motivation (10%) and a positive attitude (20%) were mentioned with some impressed by the positive motivation toward work shown by some team members and disappointed by the lack of motivation in others.

In the team work based themes the most common theme was the importance effective communication (35%) so as to keep each other informed about the work, listening to the ideas and opinions of others and how to communicate in a way which engages others rather than alienating them. Other themes less often mentioned were: needing to show greater assertiveness by speaking up meetings; being willing to disagree (10%); and willingness to accept and provide criticism (10%). Some students (10%) had appreciated the advantages that technology (such as Google docs) provided to enhance communication. Other themes mentioned were team leadership and management (20%) with some team leaders describing how they were learning how to gain cooperation from team members and others impressed by the leadership skills by their team leader. 20% mentioned that they had learned to appreciate different perspectives and approaches provided by other students while 10% mentioned development of mutual respect for the skills and abilities of other team members.

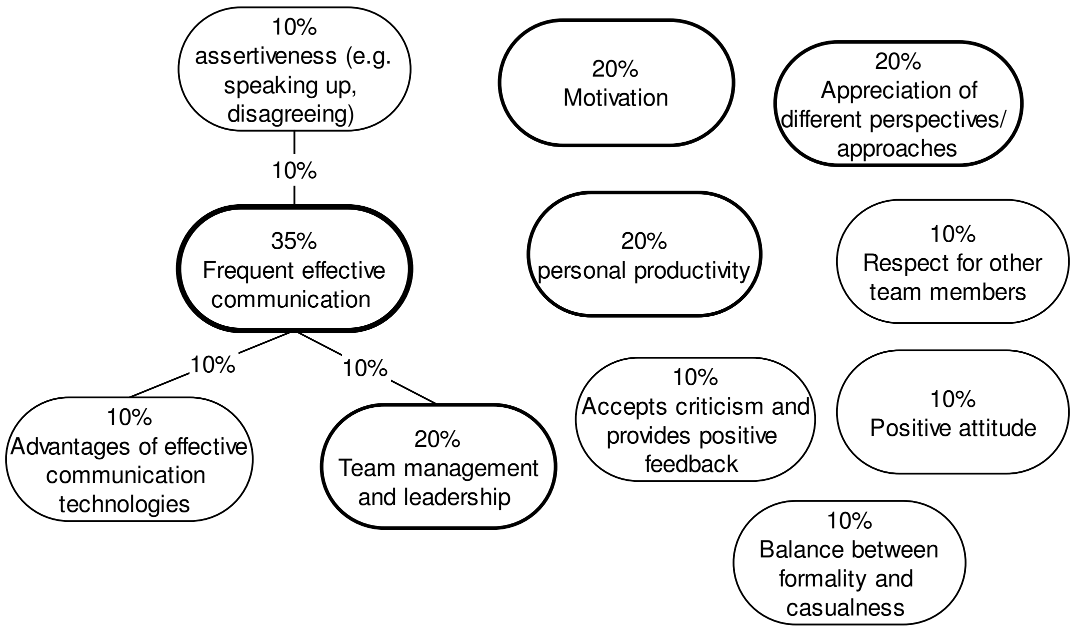


**Figure 26 Journal 2 Q7 UG threshold 10%**

PG: 13 students

PGs mentioned team based themes more than individual development. 46% mentioned team leadership or management describing the value of defined roles for members, being organised and focussed while others described the need for flexibility. 38% mentioned effective communication including overcoming shyness or fear so as to be able express ideas and then being able to express those ideas clearly; related to this was the theme of willingness to accept and give criticism (15%). Other themes mentioned were supporting team members (15%), working towards team goals (15%) and appreciating the different perspectives and approaches brought by other team members (15%).

On a more personal level 31% described getting ideas about improving their own personal productivity through observing other students techniques for researching, reading and task management. 23% described critical thinking issues related to problem solving techniques and just thinking through things before acting.

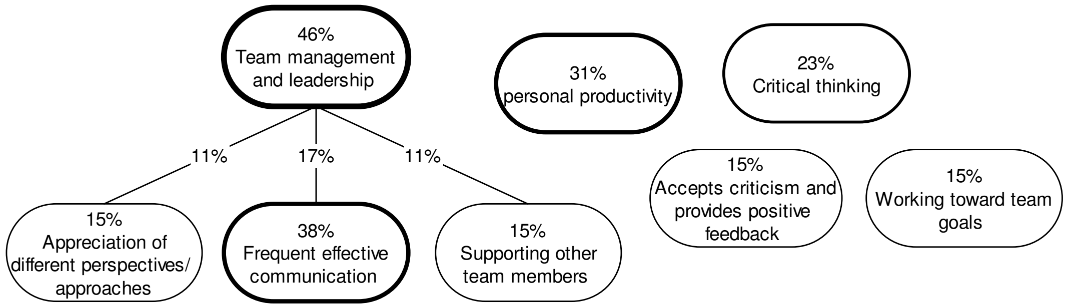


**Figure 27 Journal 2 Q7 PG Threshold 10%**

## Question 8 & 9 Outcomes from supervisor meetings

**Q.8 The meetings held each week with your academic supervisor and fellow team members are intended to encourage discussion to clarify ideas, highlight problems, suggest problem solving strategies and generally share ideas and viewpoints between the team members as well with the supervisor. What have been the most important outcomes from these discussions for you since the last journal?**

**Q.9 Since the last journal, are there any tasks or issues that your supervisor assisted you with? If so what were they? Would you still need assistance if the same task was required in future or do you believe you could handle it satisfactorily by yourself (or with your team members). Do you think that this assistance could have been provided in a better or different way?**

*Q.8 is a cognitive apprenticeship question relating to modelling, learning from a coach and community of practice. It also tries to determine the effectiveness of the discussions in articulating ideas and improving understanding.Q.9 is a cognitive apprenticeship question relating to coaching support and indirectly to scaffolding and fading.*

### Overall

Both postgraduates and undergraduates (88% and 65% respectively) appreciated the role of the supervisor in keeping the team on track toward a satisfactory completion of the project by either confirming that their progress appeared satisfactory, providing guidance on how to get it back on track or simply urging them not to slacken the pace of work. Students appreciated the feedback on the quality of many aspects of their project whether it work that they were producing e.g. presentations, reports (65% undergraduates, 41% postgraduates), meeting minutes, action plans, project schedules etc. or the way in which the team or a particular individual operated e.g. leadership, management, workload, team interaction, productivity and so on. These were issues which many students felt unsure in the context of dealing with a real world client with a real problem to be addressed and supervisors needed to use their judgment (and on a few occasions also requiring consultations with other supervisors).

Supervisors helped teams to better understand and clarify their ideas (undergraduates 50%, postgraduates 65%). Examples mentioned by students related to understanding the problem, the contextual issues, requirements specification, assessing solutions, asking probing questions which highlighted areas where further work was required. Supervisor meetings were also a regular time that encouraged teams to pause and reflect more deeply about their project and what they were doing.

Supervisors also facilitated the team dynamics, organisation or management (undergraduates 20%, postgraduates 24%) such as more efficient allocation and division of work, more effective leadership style, better communication strategies, encouraging greater contribution from all team members etc. Guidance on personal development issues such as overcoming shyness, better personal organisation, accepting and learning from criticism, personal attitudes and so on were also mentioned (undergraduates 20%, 24% postgraduates).

### UG: 20 students

The most highly mentioned theme by 70% of UGs was getting advice on their team's progress, whether it was on the right track or getting guidance to get it back on track. One student commented that their supervisor "helped us by providing ongoing feedback and direction for our approach to the problem". An important contribution of the supervisor is "making sure we have been making consistent progress" when they might other wise be inclined to ease off. Even if a team is working well a confirmation of this by their supervisor is reassuring, "The affirmation of thoroughness and sound team organisation was important to boost morale and confirm that we are on-track."

65% of students mentioned that the supervisor provided feedback on the team's work and made suggestions as to how it could be improved. Work mentioned by various students was:

- The purpose, content and structure of presentations, reports, requirements, minutes etc which they understand in broad sense but need to be refined to suit the specific project.
- Whether the work is sufficiently researched, detailed or at an appropriate standard.

- Appropriate application of particular RAD models or techniques e.g. data models, process models, use case models, writing of specifications, requirements gathering etc.
- Determining and then appropriately defining the problem and solution scope
- Critical thinking e.g. presenting logical arguments, providing sufficient evidence for and justifying recommendations or conclusions
- Typical practices adopted with RAD deliverables

With all of the above the supervisors needed to use their judgement about what is sufficient or satisfactory taking into consideration their experience and adjusting for the fact that these are capstone projects.

50% of UGs mentioned that supervisor meetings were useful as they provided increased understanding in aspects of their project or clarified or developed ideas. As one student put it "*progress meetings have undoubtedly allowed us to clarify problems, requirements and reassess our current solution and approach to the problem*". Another student praised their supervisor who "*has been of fantastic assistance particularly with general guidance, clarification of ideas and problem solving strategies.*"

A theme of significance was the supervisor facilitating team dynamics, organisation or management (20%). This might relate to providing advice on more efficient division of work, managing deadlines, leadership style and one case helping a team negotiate a change of leader. Another theme related to personal development (20%). In the case of a team leader who was replaced, while the student involved found it a hurtful and embarrassing experience he realised that he had been somewhat arrogant and his organisational skills needed to be improved. In another case, the "*supervisor explained & provided help in the way I can build up that confidence & contribute effectively to the group*". Another student described how the supervisor "*encouraged every team member to work professionally in this project*".

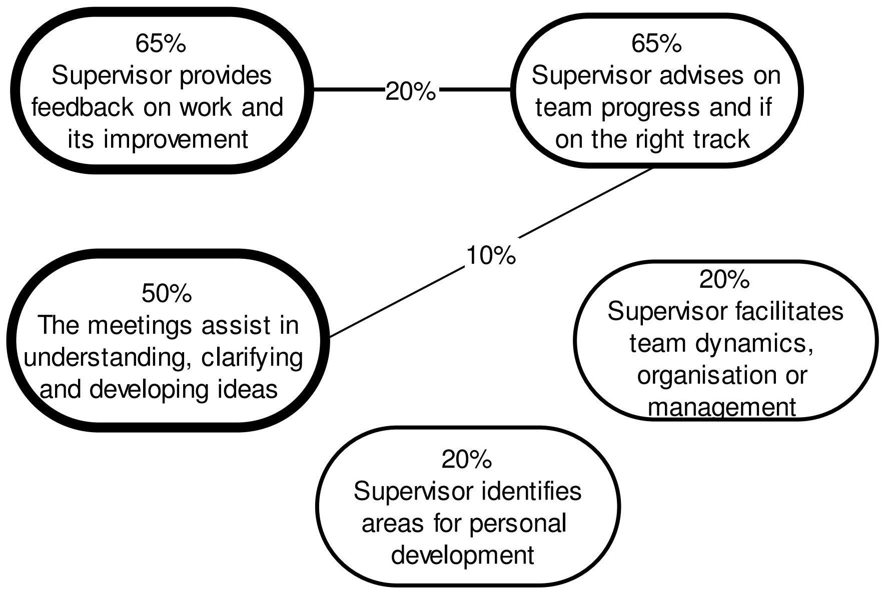


**Figure 28 Journal 2 Q8&9 UG Threshold 10%**

PG: 13 students

88% commented on getting supervisor feedback on the teams work. Topics were similar to UG although PGs tended to be less specific about the areas of work.

Another strong theme was the usefulness of the supervisor meetings in helping in understanding and clarifying and developing ideas (65%). For some students these meetings provided a time which was highly focussed and productive, "*we got almost all the ideas on the meetings because such meeting time were dedicated and we could listen and think about the project carefully*". Supervisor meetings could be a rich source of ideas or a time when ideas were explored or challenged; one student described how they had to "*better think about the problems we considered insignificant by answering the questions thrown at us*" or because the supervisor wouldn't confirm a team's proposed solution was "correct" this urged the team to do more research into their solution.

Another strong theme for PGs was the supervisor providing advice on team progress and being on track (41%). PGs were less concerned about their overall progress but when they had at times been off track in some aspect of the project (e.g. goals, focussing too much one possible type of solution and ignoring others completely, not doing the requisite research etc.) they appreciated that their supervisor had guided them appropriately.

A theme of significance was the supervisor facilitating a team dynamics, organisation or management (24%) which was similar to UGs. None of the PGs mentioned personal development issues.

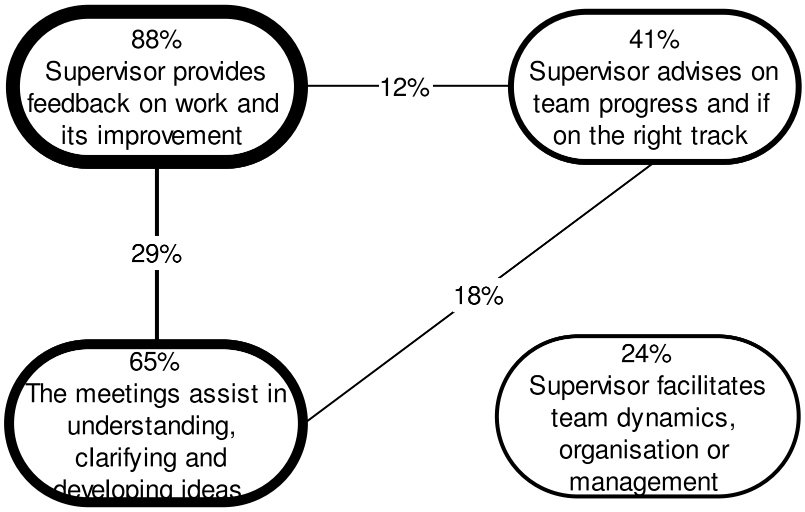


**Figure 29 Journal 2 Q8&9 PG Threshold 10%**

## Questions 10 & 11 Possible improvements and other thoughts

**Q.10 Is there anything that you believe could have been improved up to this point or could still be improved for the remainder of the semester?**

**Q.11 Any other thoughts?**

*Q.10 is a cognitive apprenticeship question relating to finding gaps weaknesses in the teaching approach. Q.11 is usually ignored by students but you never know what might come up.*

I was not able to derive much from this. Some UGs were somewhat “whingy” wanting more time with clients, didn’t like the altogether group sessions where they had to wait to see their supervisor, wanted faster turnaround from clients, wanted only one-on-one time with clients. One UG was upset that the client had made no attempt at solving their problem themselves and that Information Technology Services was contemplating introducing software that might affect their proposal – this supposedly suggested that the project was not serious. PGs on the other hand were quite positive and appreciated what they were given (the project opportunity, supervisor support, client input etc.) rather than concentrating on negatives.

# Journal 3 analysis

## Introduction

Journal 3 was submitted at the end of the project. While the project duration was 12 weeks this journal could have been submitted up to a week later as students were asked to respond to it only after all significant tasks for the project had been completed. In the last few weeks the most significant tasks would have been to finalise their recommendations, write their final report to the client and to deliver their final presentation. While the first few questions were related to these tasks the later questions asked students to reflect back on the project as a whole on what they had learned through their involvement in the project.

## Question 1 Aims for final presentation

**What were your aims in your final presentation? In what ways did it go particularly well or badly? Any there any aspects which you wish you had done differently or better in preparing for the presentation?**

*This is judgement question related to understanding the audience and providing a presentation that will meet their needs and expectations. It also relates to being able to present an argument and to defend a position which is an important part of judgment.*

### Overall

Most UGs thought that their final presentation went well (55%) compared to only 36% of PGs. Specific reasons why they believed it had gone well was the interest shown by their client at question time or that the presentation went smoothly from their perspective. Those UGs that stated that their team's overall presentation could have been better (45%) were more inclined to criticise the performance of other team members (20%) and not their own performance. 40% of UG students mentioned concentrating on successfully doing their part and were inclined to suggest that their contribution could have been better (20%). In contrast no PG students mentioned concentration on their own particular performance or criticised the performance of the other team members.

With regard to rehearsing, the students' perceived performance seemed at odds with effort spent rehearsing. Although overall UGs were positive in their self evaluation of the presentation, 55% of UGs thought that their presentation was under rehearsed compared to 20% who thought it was well rehearsed. On the other hand, although PGs were less positive about their presentation, 50% of post graduate students thought that their presentation was well rehearsed. A possible interpretation is that PGs were more critical in their self evaluation of the presentation. One UG student for example commented on a couple of technical mishaps and problems with timing in the presentation and suggested that more rehearsal might have helped but still thought the presentation had gone well.

### UG: 20 students

Most UGs thought that their final presentation went well (55%) although only a few gave specific reasons why they believed this e.g. the interest shown by their client at question time or that the presentation went smoothly from their perspective. 55% thought that their presentation was under rehearsed compared to 20% who thought it was well rehearsed. Those that stated that their team's overall presentation could have been better (45%) were also inclined to show some concern about the performance of other team members (20%) but not their own. The 40% of students who mentioned concentrating on successfully doing their part were also inclined to suggest that their contribution could have been better (20%). Those who expressed concern about personal performance were less likely to discuss the general aspects of the presentation such as the proposed recommendations, description of methodology used or logical presentation of idea and arguments.

There were several themes regarding the aims of the presentation that were mentioned. The major theme from 40% of students was that they wanted to demonstrate their methodology and build credibility for their solutions. 35% mentioned simply that they wanted to present their solutions while another 30% saw the presentation as trying to sell or promote their solution. 30% suggested that the client was the focus of their presentation while another 25% stated more generally that the presentation should be well targeted to the audience (comprised of the client and any guests that they had invited as well as academic staff reviewing the presentation).

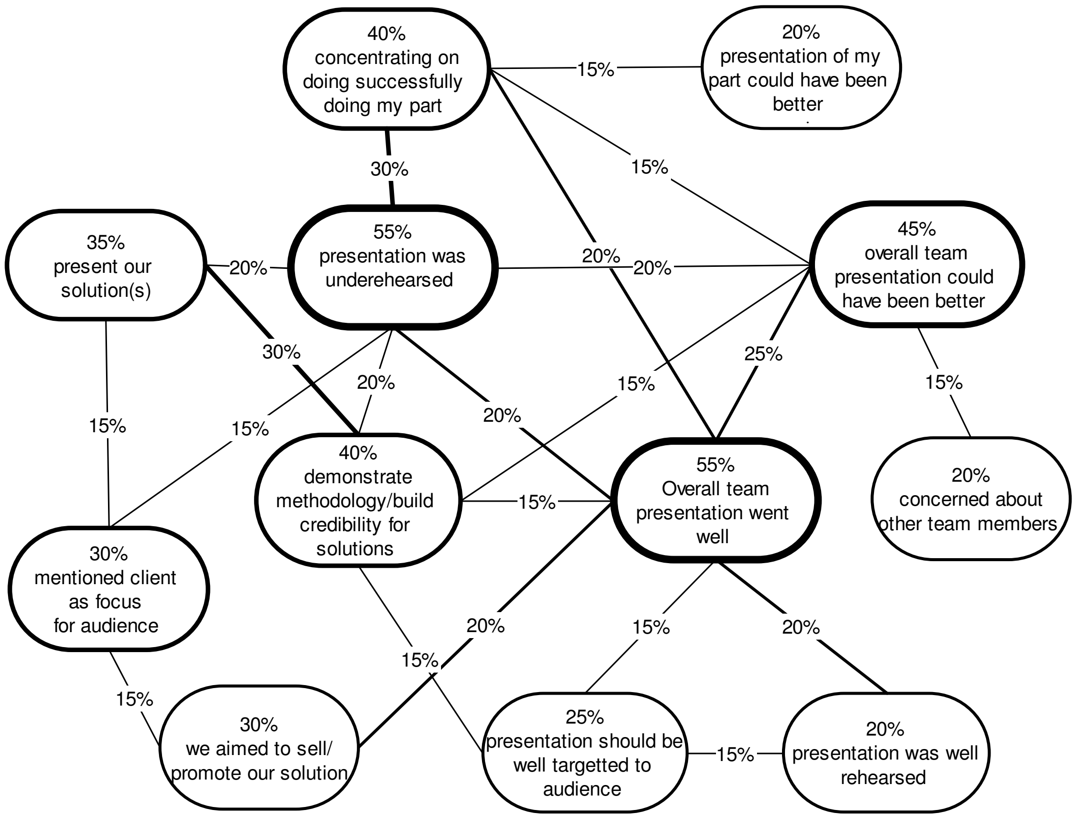


**Figure 30 Journal 3 Q1 UG**

PG: 14 students

While 50% of post graduate students thought that their presentation was well rehearsed, only 36% of PGs thought that their final presentation went well and 50% stating that their presentation could have gone better. In terms of the aims of the presentation 50% of post grads wanted to demonstrate their methodology and build credibility for their solutions and nearly all of these also mentioned presenting their solutions (36%). 50% of post grads mentioned the client is the focus of the audience while 21% mentioned that the presentation should be well targeted to the audience.

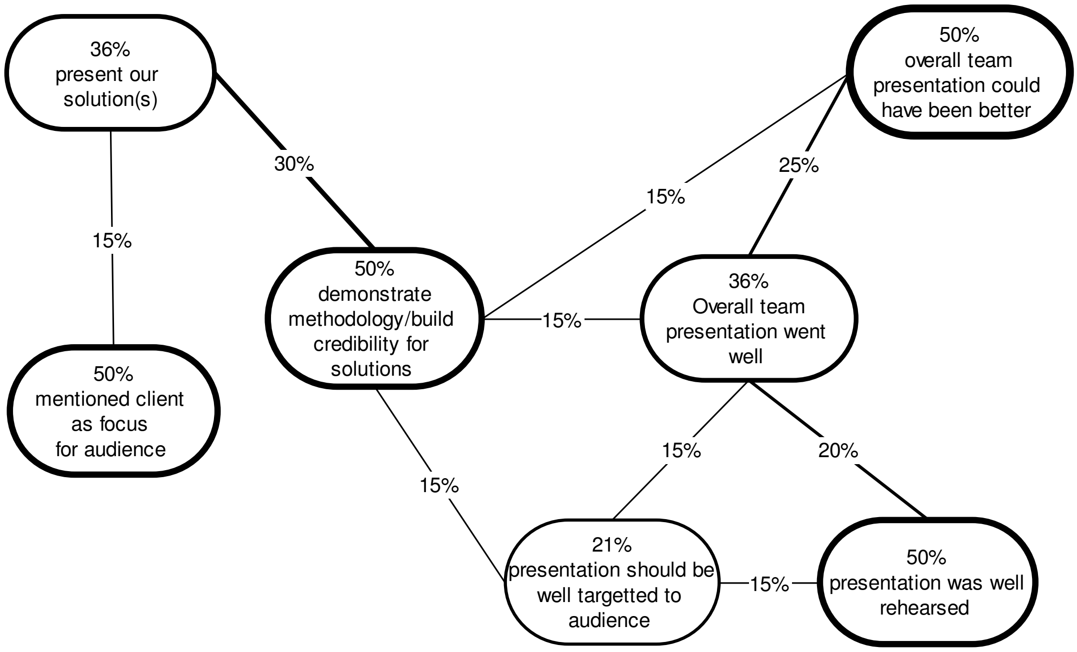


**Figure 31 Journal 3 Question 1 PG**

## Question 2 Final report issues

**To what extent did you provide input into the final report? Did you feel that you understood what was required? What difficulties did you encounter either personally or from the perspective or coordinating and refining the work of the team members?**

*This is a judgment and cognitive apprenticeship question. Ideally, the report needs to present a compelling and well-reasoned case which justifies the solutions or findings. It needs to satisfy both the client's and supervisor's expectations.*

## Overall

100% of UG students and 82% of PGs stated or implied that they had made a significant contribution to their team report. 50% of UGs and 76% of PGs stated that they understood what was required in their report. A few PGs (but no UGs) mentioned looking at previous reports that were provided as a useful guide.

60% of UGs stated that that the task of reviewing and consolidating the report required significant effort compared to only 35% of PGs. While 25% of UGs expressed frustration with other team members being tardy with their contributions or providing work of poor standard, 30% also stated that other team members had made a significant contribution to their final report. PGs tended to be more positive and less personal in their discussion of the production of their report. While 35% found the process of reviewing and consolidating the work challenging and 24% finding that coordinating team members something of a problem, 29% stated that they thought the process went smoothly. Based on observation and supported by these student responses, an interpretation is that within teams there tended to be one or more members who had the major responsibility for report production and dealt with the real problems of coordinating efforts, reviewing and consolidating the report while others simply contributed their sections. For the latter students the process might seem fairly straightforward.

In comparing the UG and PG groups, UGs either seemed to have more difficulties working with some team members (e.g. team members being unreliable or tardy) or quality of contributions (e.g. team members' writing skills). PGs seemed less personal in criticisms and generally described problems in the process. Some speculations on this difference are that it might be simply random, PGs are, on average, somewhat more responsible as team members, less inclined to complain or maybe a bit more forgiving of other team members' weaknesses.

### UGs 20 Students

All UG students claimed to have made a significant contribution to the report writing although it was clear that some put a great deal more effort than others. (In the diagram below this theme was not added on the basis that all students stated this and only introduced clutter to the diagram). 50% of students stated that they understood what was required for the report. 60% of UGs stated that there had been a great deal of work involved in reviewing and formatting their report and most of these were those who stated that they understood the report requirements. 30% of students mentioned that the use of online collaboration tools had provided significant support for report writing. The tool exclusively mentioned and used was Google docs (although students were aware of other software which could have been used and which was available).

While 25% of UGs expressed frustration with other team members being tardy with their contributions or providing work of poor standard, 30% also acknowledged that other team members had made a significant contribution to their final report.

20% of students mentioned that they had difficulties in physically getting together for the purpose of writing the report.

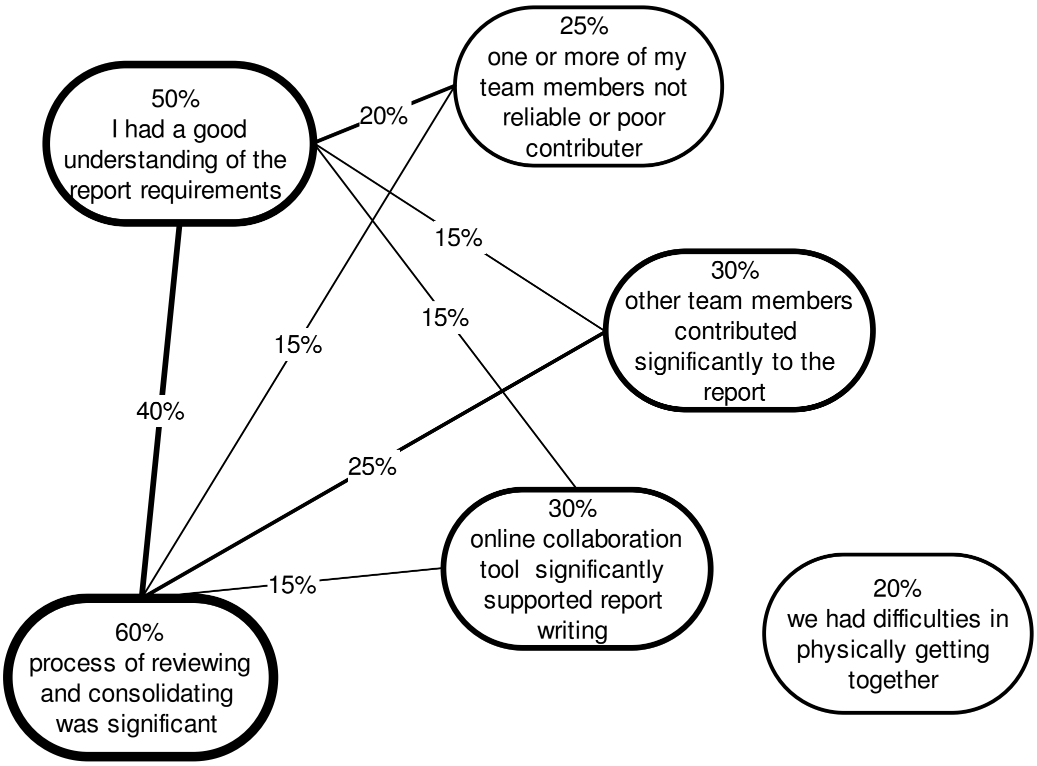


**Figure 32 Journal 3 Question 2 UG**

PG: 17 students

82% of PGs stated that they had made a significant contribution to their team's report. (Similarly to the above diagram this theme was not added to the diagram for PGs below). 76% of PGs stated that they had a good understanding of the report requirements (often mentioning having availability of previous reports helpful). The 29% of all students who stated that the production of the report went relatively smoothly also stated that they understood the report requirements. 35% found the process of reviewing and consolidating the report as significant but in contrast PGs there was less complaint about lack of contribution (12%) by other team members.

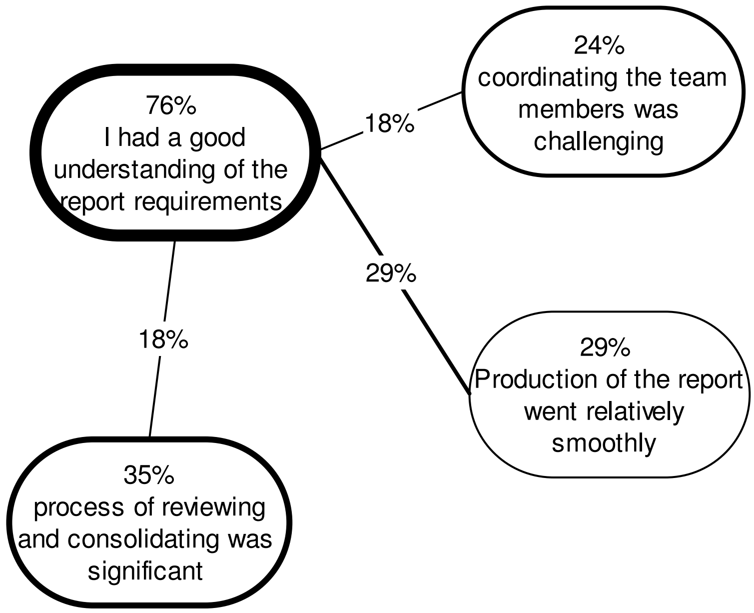


**Figure 33 Journal 3 Question 2 PG**

## Questions 3 and 4 Supervisor support

**Question 3 The meetings held each week with your academic supervisor and fellow team members are intended to encourage discussion to clarify ideas, highlight problems, suggest problem solving strategies and generally share ideas and viewpoints between the team members as well with the supervisor. What have been the most important outcomes from these discussions for you since the last journal?**

**Q.4 Since the last journal, are there any tasks or issues that your supervisor assisted you with? If so what were they? Do you think that this assistance could have been provided in a better or different way? Would you still need assistance if the same task was required in future or do you believe you could handle it okay by yourself (you alone or with your team members).**

*These were combined because they were closely interconnected and also because students tended not to differentiate much between the two.*

*Question 3 is a cognitive apprenticeship question relating to modelling, learning from a coach and community of practice. It also tries to determine the effectiveness of the discussions in articulating ideas and improving understanding.*

*Question 4 is a cognitive apprenticeship question relating to coaching support and indirectly to scaffolding and fading.*

## Overall

The strongest theme mentioned by 70% of UG students and 76% of PGs was that supervisors provided advice and feedback on the final presentation to the client (this presentation also involved two or three academic staff as judges). Mentioned was presentation style, ordering of ideas and content and the need to provide evidence and rationale. In terms of content that would be considered relevant to include some of the points mentioned were the research undertaken to find candidate solutions, means by which recommended solutions were determined etc. Points judged as not relevant were mentioning of internal team functioning and dispute resolution etc.

There were a variety of comments of a general nature about supervisors altering ways of thinking. Some comments related to providing different perspectives e.g. "*Supervisor assisted me in terms of presenting solutions to the client in clearer and simpler way. He helped me to know and understand the client is non IT person*" or "*According to me the most important outcome was to see how I refined my thoughts in terms of understanding the project [to the] supervisor point of view*".

The next strongest theme at 50% and 65% for PGs was providing advice and feedback on the final report but there little detail of the advice provided. The higher score of PGs compared to UGs with regard to report writing might be explained by the fact that PGs tended to be international students for whom English was often not their native language and also less confidence in the cultural expectations.

30% of UGs mentioned that their supervisor helped in discussing and clarifying ideas brought by team members whereas this was not a significant theme amongst PGs. Amongst UGs, one student stated *"[Our supervisor] has been a valuable resource in mining and developing our numerous business ideas for the client*". Another student mentioned that "*more of our discussions took place about 'outside the box' type ideas and this is where our discussions would lead off. Our team as such have a lot of ideas and it was really good talking to our Supervisor about them.*" Finally, "*each member typically has their own view and during the weekly meeting, the supervisor helps clarify such thoughts*."

It is clear that keeping the project on track was still an issue for some students even in the last stages of their project (25% of UG and 12% of PG). As one student mentioned "*the tracking of our progress and seeing where we stood with our timeline. It was important to know that we were on the right path.*"

In terms of finding the finding appropriate solutions, 25% of PGs mentioned discussion with their supervisor.
35% of UGs and 41% of PGs stated they would not need as much help in the future which presumably could be interpreted to mean that they believed had learned skills that they could use in the future.
A weak theme (10%) for UGs worth mentioning which did not appear at all for PGs was students complaining that they did not know exactly what was required e.g. "*I felt like with this subject in general there was a lack of clear outlines and an indication of what exactly was required*" and similarly another student who complained about "*the absence of marking guides*".

## UG: 20 students

The strongest theme mentioned by 70% of UG students was that supervisors provided advice and feedback on how to go about the final presentation to the client (this presentation also involved two or three academic staff as judges). Some of the points mentioned were that the content that was relevant (e.g. research undertaken to find candidate solutions, the methodology used to arrive at the recommended solutions etc.) and not relevant (e.g. internal team functioning, dispute resolution etc.), presentation style, ordering of ideas and content, providing evidence and rationale. The next strongest theme at 50% was providing advice and feedback on the final report; little was provided in the way of examples however. 30% of UGs mentioned that their supervisor helped in discussing and clarifying ideas brought by team members. One student stated "*[Our supervisor] has been a valuable resource in mining and developing our numerous business ideas for the client*". Another student mentioned that "*more of our discussions took place about 'outside the box' type ideas and this is where our discussions would lead off. Our team as such have a lot of ideas and it was really good talking to our Supervisor about them.*" Finally, "*each member typically has their own view and during the weekly meeting, the supervisor helps clarify such thoughts.*" It is clear that keeping the project on track is still an issue for students even this far into the project. One student mentioned "*the tracking of our progress and seeing where we stood with our timeline. It was important to know that we were on the right path.*"
It would appear that a small percentage of students (10%) did not appreciate uncertainty and ambiguity and wanted predictable outcomes. For example, "*I felt like with this subject in general there was a lack of clear outlines and an indication of what exactly*

*was required*" and similarly another student who complained about "*the absence of marking guides*".

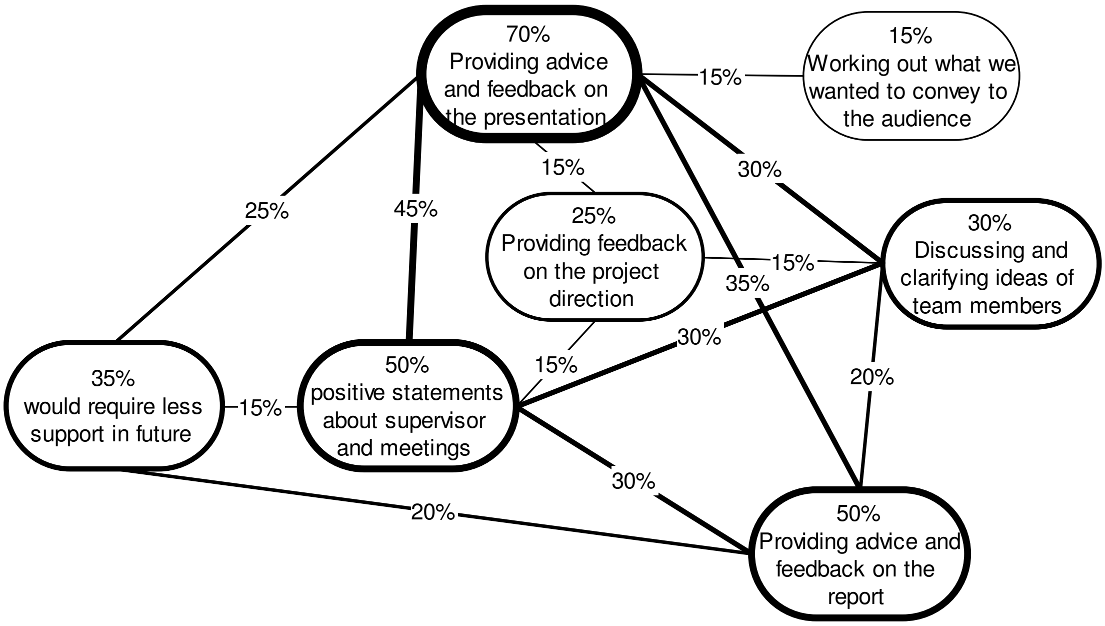


**Figure 34 Journal 3 Question 3 &4 UG**

PG: 17 students

The strongest themes regarding the support provided by supervisors among PGs was getting advice and feedback on the client presentation (76%) and final report (65%). Many students (65%) had generally positive statements about their supervisor and the meetings held.

There were a variety of comments of a general nature about supervisors altering ways of thinking. Some comments related to providing different perspectives e.g. "*Supervisor assisted me in terms of presenting solutions to the client in clearer and simpler way. He helped me to know and understand the client is non IT person*" or "*According to me the most important outcome was to see how I refined my thoughts in terms of understanding the project [to the] supervisor point of view*". Sometimes it was related to confidence and encouragement, "*He always tried to give some positive feeling by having a discussion with us regarding our work which made us more committed towards this unit. I personally felt relaxed whenever we had a discussion with our supervisor because in that discussion … with patience he clarified all our doubts*." Another student commented on encouraging their critical thought, "*The most important outcome was in the level of thinking and the depths I leaped into thinking about even about a minute detail*" and later, "*it was with regard to the level of expectations from us and the* *way we had to perform in order to excel as we come out of the educational arena and step into a career centred environment*".

24% of PG students mentioned discussions about the candidate solutions and finding the most satisfactory solutions. 41% of students stated that they would require less support in the future.

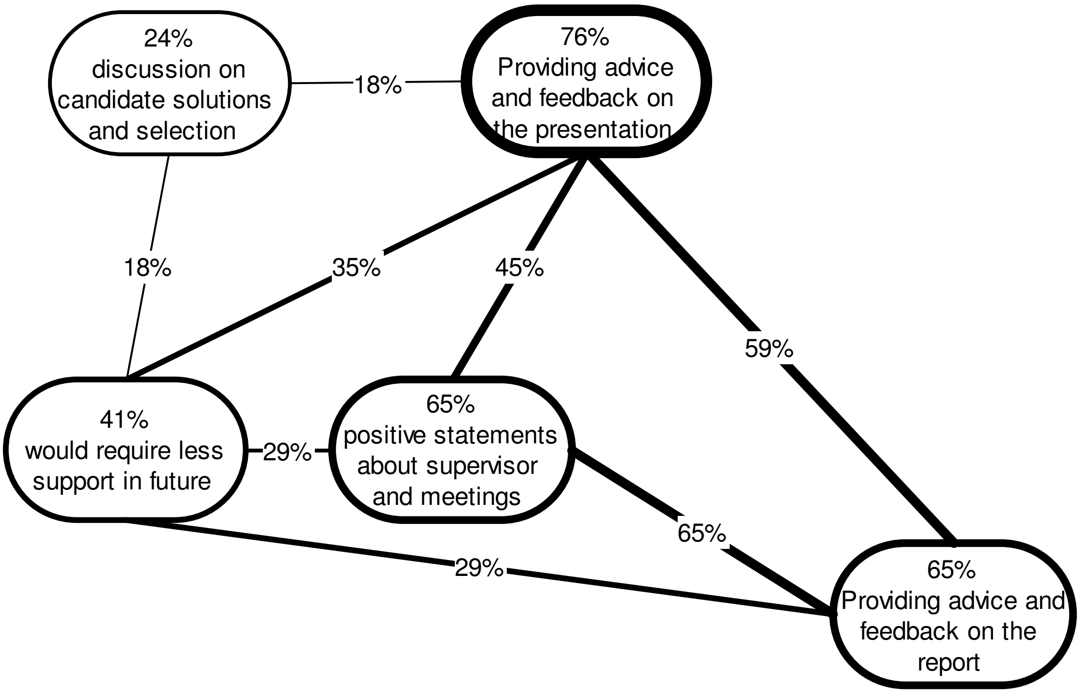


**Figure 35 Journal 3 Question 3& 4 PG**

## Question 5 Principles demonstrated by supervisors

**What stands out to you as some of the more important principles or values that your supervisor has emphasized to you about projects like these? These may have been stated explicitly (i.e. directly in words) or they may have been implicit (i.e. not stated in words but implied through their attitudes or value judgments).**

*This is a cognitive apprenticeship in that it asks for guiding principles demonstrated both explicitly and implicitly from their supervisor. It also a judgement question in RAD since it asks for principles and values.*

### Overall

For all students the strongest themes responses related to project management (UG 35%, PG 24%), teamwork (UG 30%, PG 18%) and working with the client (UG 35%, PG 24%). A common theme within teamwork and the working with the client there was also the theme of communication (UG 30%, PG 24%). In regards to project management students mentioned planning ahead, the assignment of roles to members and clear, transparent and explicitly recorded allocation of tasks with timelines as key points made by supervisors. The students who mentioned project management were also likely to discuss the importance of effective team communication as well. One student described communication as the "*cornerstone of a successful project*" while another mentioned as important to resolving internal issues within the team. Some points mentioned were that communications needed to be frequent and being able to see things from the client's perspective.

Critical thinking skills were mentioned significantly although not strongly by both UGs (20%) and PGs (18%). Maintaining a positive attitude was mentioned by 20% of undergrads but not by postgrad students.

Other weaker themes also mentioned were the development of presentation skills, understanding the problem and scope management, to think holistically and creatively, and problem solving skills.

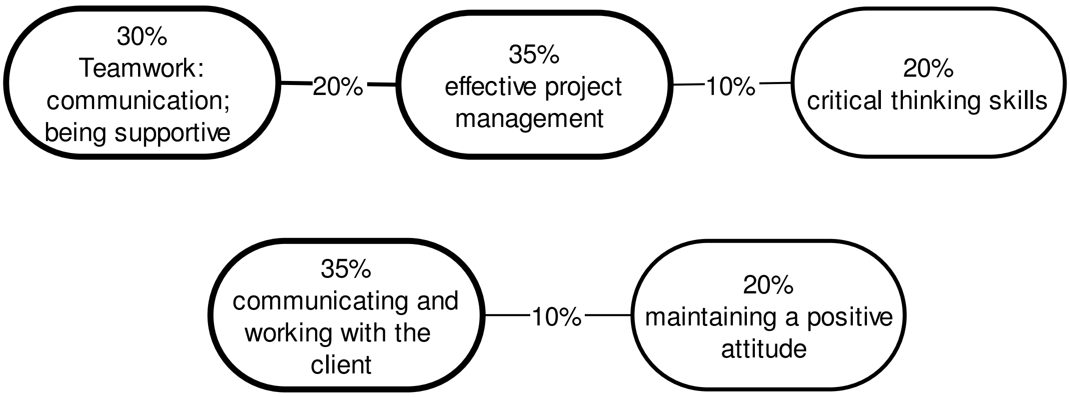


**Figure 36 Journal 3 Question 5 UG**

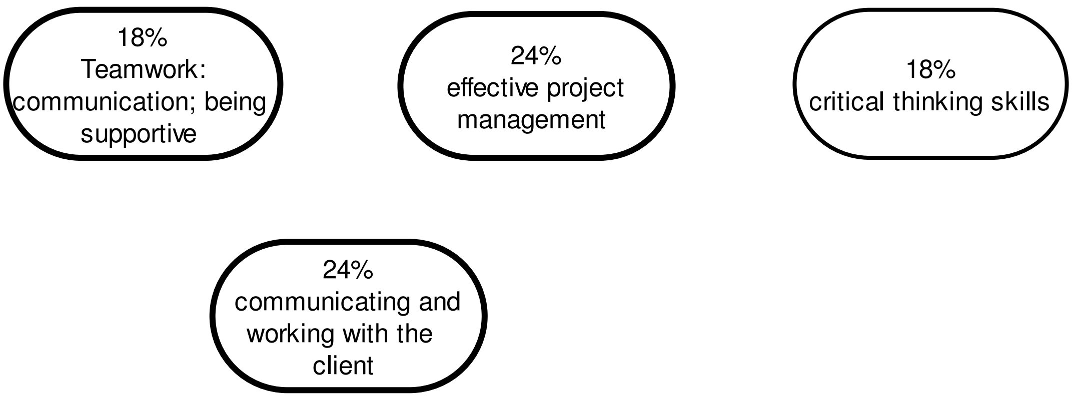


**Figure 37 Journal 3 Question 5 PG**

## Question 6 Application of previous learning

**Reviewing previous subjects you have done e.g. Systems Acquisition and Implementation Methodologies, Business Intelligence, Requirements Analysis and Modelling, Enterprise Systems, Process Modelling, Project Management what theories, knowledge, skills or processes did you find most relevant and appropriate to apply this project? (If you have many things that you could mention, just mention the ones that seemed most important to you)**

*This is a judgment question since it asks them to link the work they have learned in prior subjects to the work in the project. Expertise needs to be familiar with the body of knowledge, skills and practices of the profession. This should be cross checked with the final report and supervisor's observations.*

### Overall

Across both UG and PG students the most cited units of study were

- Systems Acquisition and Implementation Methodologies (UG 80% and PG 82%). This was largely because of the methodology it provided in assessing and evaluating software.
- Requirements Analysis and Modelling (UG 71% and PG 35%) mainly regarding requirements gathering and definition.
- IS Project Management (UG 35% and PG 59%) with scattered comments related to report writing, work breakdown, planning.
- Business Process Modelling (UG 35% and PG 29%) in terms of understanding and modelling business processes.

Given the nature of the projects allocated to students in the semester that this research was conducted these results are not surprising. It is difficult to draw conclusions. Requirements Analysis and Modelling and IS Project Management are relatively generic and would be expected to more consistently mentioned across a wider variety of projects while Systems Acquisition and Implementation Methodologies and Business Process Modelling might be more specific to particular types of projects.

## Question 7 Understanding of the project

**At which point in the project (if ever) did you feel that you understood what you were trying to achieve and how to get there? If you did, was there anything in particular that helped you with this or did your prior knowledge and experience**

**make it obvious to you? If this understanding didn't come till the end or still is not there even now, what aspects didn't or don't you feel sure about?**
*This is a cognitive apprenticeship question related to the global view and trying to pinpoint gaps or points of confusion.*

## Overall

This set of questions appears to be open to a variety of interpretations. Some may have interpreted this to mean that they understood the broad features enough to start the project while others at the other extreme believed they didn't understand it fully until they had completed the project and were able to reflect back on it from start to finish. Students could also be expressing their self-confidence at a certain point in time which may not have aligned with the supervisor's assessment of the student's understanding of the problem and task. Be that as it may, overall undergrads students expressed more confidence in their understanding of the project compared to postgrad students. 35% of UGs thought they understood the project compared to 18% of PGs in the very early stages of the project i.e. after one or two client interviews. By midway through the project when several interviews had been completed and some initial research would have been accomplished 40% of UGs compared to 41% of PGs stated that they understood the project. In the latter stages of the project when teams would have been refining solutions and/or preparing for presentations 18% of PGs (and no UGs) stated they understood the project. UGs stated that their understanding grew with further stakeholder interviews (30%) or that the details became clearer (20%). 24% of PGs stated that their understanding grew with further stakeholder interviews. Both UGs (24%) and PGs (20%) found that some form of prior knowledge help them to understand what was required. Overall, one possible interpretation of this is that undergraduate students were simply more confident earlier on in the project when the scope and objectives were still somewhat vague, while postgraduates became more confident later in the project when achieving the project objectives was more clearly in sight.

## UG

35% of UGs thought that they had a good understanding of their project very early indicating this occurred after the first or second interview. Another 40% of UGs believed that they understood the project a little later (nearly halfway through the project) which coincided with preparing for a formal progress presentation to the client which included a problem, scope and requirements description and possibly having begun some research. Nearly all these students also admitted that their understanding evolved as they interviewed more stakeholders or as the project progressed. There were 10% of students who stated that they only fully understood the project around the time of preparing their final presentation and report. Responses need to be viewed from the perspective that there could be various interpretations by students of the term “understood”. The remaining students (15%) did not address the questions and discussed other issues.

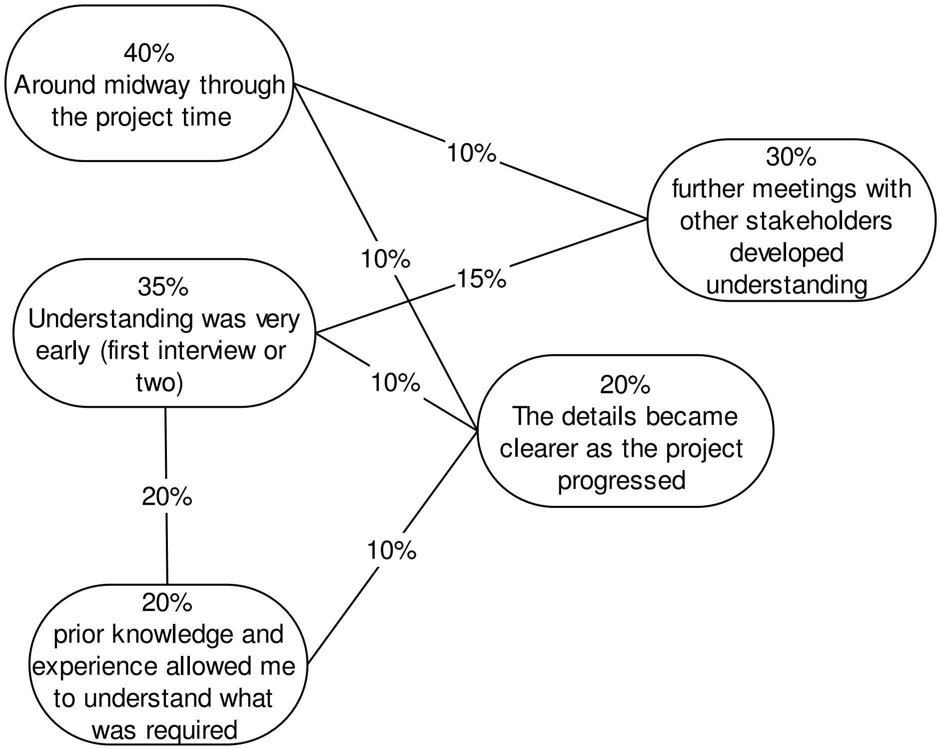


**Figure 38 Journal 3 Q7 UG**

PG

PGs were a little less confident of their understanding of the project compared to UGs. Only 18% stated that the understood the project and how to tackle it at the earliest stages while and 41% of PGs believed they understood it by mid semester. 18% thought they understood the project at the latter stages of the project. The rest (14%) stated that their understanding evolved as the project progressed but didn’t state a particular point in time.

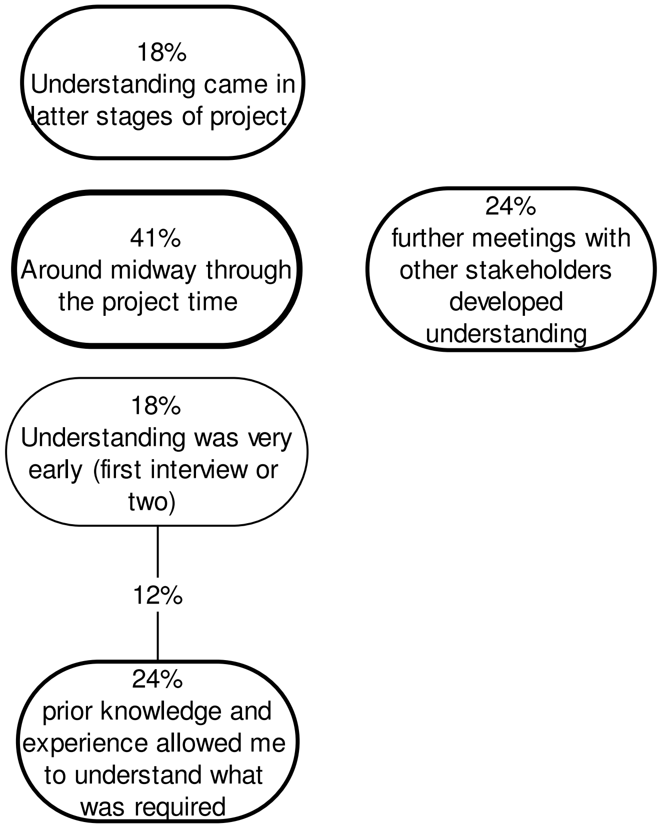


**Figure 39 Journal 3 Question 7 PG**

## Question 8 Knowledge and skills acquired

**There will always be something new or different about each project. What new (or extension of existing) knowledge or skill have you had to acquire in the project that hasn't been taught in previous subjects? If so what was it? Was there anything that you believe is missing, not covered sufficiently well or not emphasized enough that would have prepared you better for the project?**

*This is a cognitive apprenticeship question but also may relate to judgment.*

### Overall

There was a wide range of answers for this set of questions with no particular theme that stood out well above the rest. Both UGs (25%) and PGs (24%) mentioned that they had learned something significant about team work or team management. One student discussed the communications environment, "*Something new I learnt in the project was how to work collaboratively. Using Google docs and a flexible team working formation, we were able to effectively work, review and critique others parts of the report/research without having to meet up every single time we needed to discuss something. I also learnt communication skills, as some of our team members required different types of* *communication to suit their personality types*." Another student mentioned the importance of strong social bonds between team members, "*Team building was excellent in this project … it is of paramount importance to build strong relationships with team members and to understand their individual goals and objectives as to enable alignment between both parties*."

For PG's application of prior learning (41%) was easily the most dominant theme. As one student described it, "*Real time experience of doing a project is always useful in understanding the theoretical concepts studied earlier. This project gave us a chance of implementing and analysing all the concepts learnt earlier and provide a wide understanding of the concepts and also the project.*" Given that some of the undergraduate students had already had some industry experience it was not surprising that more postgraduates had appreciated a realistic project in which they could apply their knowledge and skills.

Both undergraduates (15%) and postgraduates (24%) appreciated dealing directly with the client and other stakeholders and also working in a more realistic and practical situation (undergraduates 15% and postgraduates 24%).

One area of difference between undergraduates and postgraduates was that undergraduates (15%) mentioned that there was uncertainty as to what to do and how to do it which was not a theme amongst the postgraduate students.

### UG

The items mentioned by UGs were:

- Team work and team management (25%)
- Dealing directly with the client and stakeholders (15%)
- Particular type of software application (15%)
- Working in a realistic and practical situation (15%)
- There was uncertainty as to what to do and how to do it (15%)
- Improving personal organisational skills and time management (10%)
- Application of prior learning (10%)
- Research skills (10%)
- Scope management and requirements definition (10%)

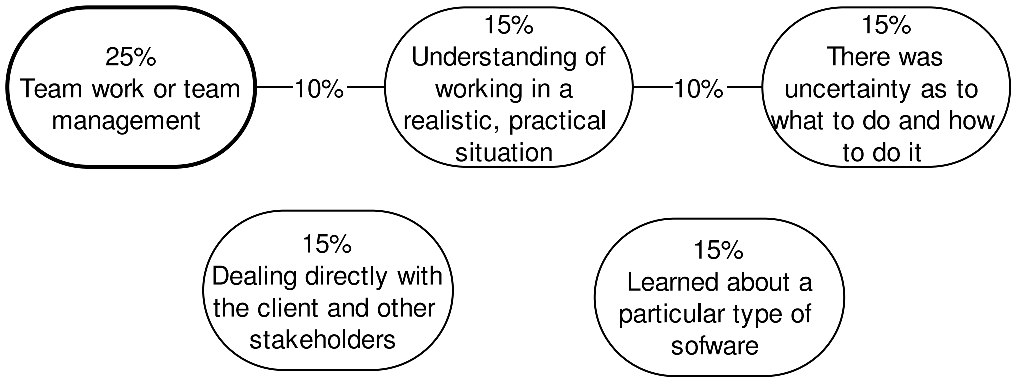


**Figure 40 Journal 3 Question 8 UG**

PG

Items mentioned by PGs were:

- Application of prior learning (41%)
- Team work and team management (24%)
- Dealing directly with the client and stakeholders (24%)
- Working in a realistic and practical situation (24%)
- Particular type of software application (12%)

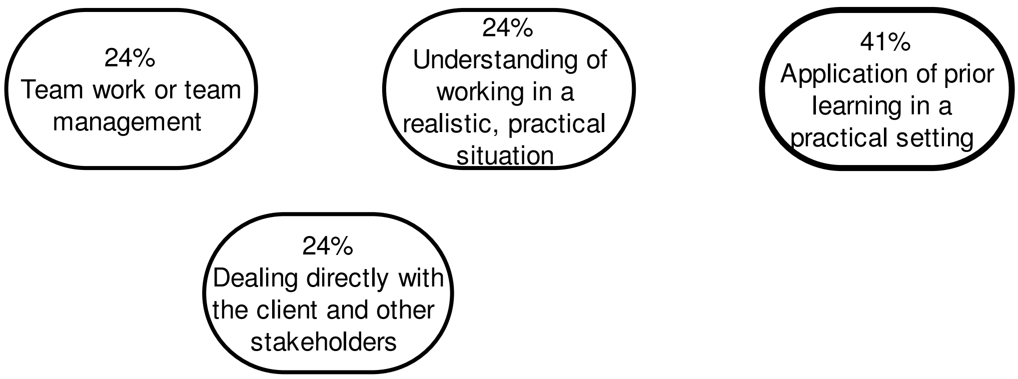


**Figure 41 Journal 3 Question 8 PG**

## Question 9 Advise to new project students

**Now that the project is over, what do you think would be the key bits of advice you would give to beginning project students or you might apply in your next project?**

*This is a judgment question since it reflects on the requirements analysis process, skills and values. Posing the question in the form of advice to others suggests that it doesn't have to be anything new but may be practical application of what may have been theoretical before. Linking it to some later use is to get them to think about extending their application to other contexts.*

## Overall

The issues that most undergraduates mentioned (55%) as did most PGs (60%) was to ensure that you understood the problem, issues and requirements as early as possible. For example "*persist in finding out the necessary information from clients, especially when they do not reveal the information that is necessary for you to complete the project. I would also advise students to thoroughly research the questions they plan to ask their clients in order to get all the information required so that they can provide a thoroughly researched solution*." Another, "*the main advice that I would offer would be to ensure that the requirements are clearly defined and the scope is accurate*". Another, "*Define the requirements as early as possible. Gather as much information as you can… Progress can be slowed if your group is still unclear on certain aspects of the project half way through a semester – so do the homework & don't be afraid to ask questions*." Finally, "*make sure that your group understands what is required first prior to beginning the research into the solution. This is a key step that sometimes can go under the radar and cause you to lose track of the bigger picture.*"

An interesting area of difference between UGs and PGs was with the issue of project management and team communication. While similar proportions of UGs (45%) and PGs (47%) mentioned this issue the UGs focussed on the importance of good communication and only tended to mention management and leadership when there had been some problem within the team. On the other hand while PGs mentioned the importance of good team communication they were even more concerned with project planning and project methodology which UGs did not mention.

Students demonstrated an awareness of the client which was mentioned by significant numbers of PGs (40%) and UGs (35%). Responses were largely centred on the need to understand the problem, scope and requirements.

Another interesting difference between UG and PGs was in team selection. A reasonable proportion of UGs (25%) mentioned choosing your team members wisely as poor team members would drag the rest of the team down as this student mentioned, "*choose your team mates carefully, as they will be the ones who will either help you achieve your aims or bring you down regardless*". This was barely mentioned by PGs (7%).

PGs were broader ranging in their themes and mentioned being creative and practical with recommendations, the value of practical application of knowledge and skills and importance of commitment to the project.

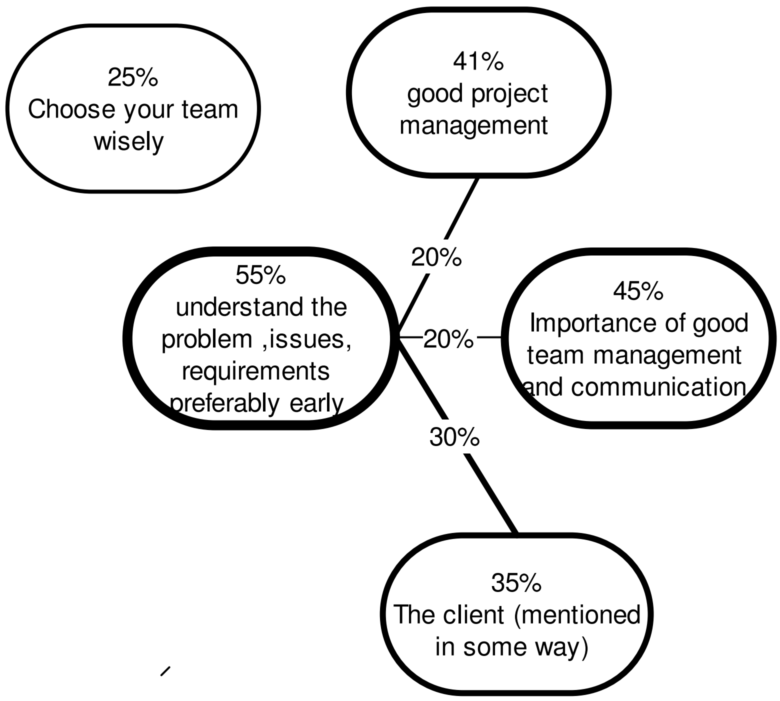


**Figure 42 Journal 3 Question 9 UG**

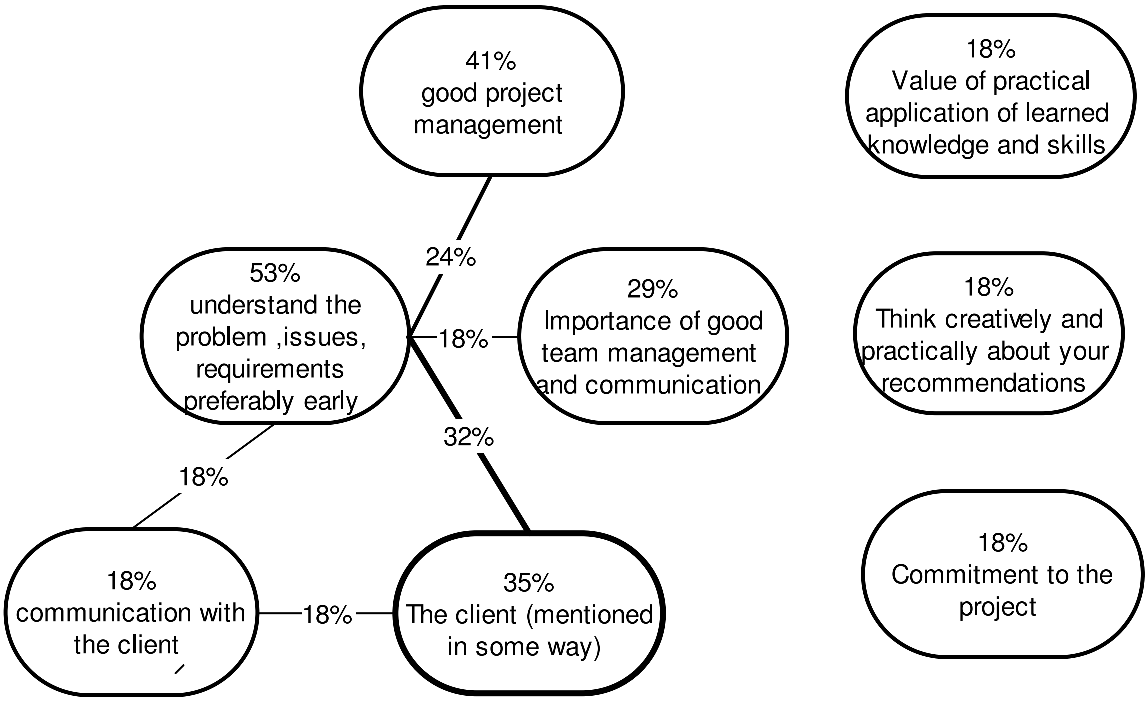


**Figure 43 Journal 3 Question 9 PG**

## Question 10 Issues regarding different personality types

**In Journal 1 you were asked to consider your personality type and that of your team members according to the Myer Briggs test and think about potential problems that might occur in your group as a result. Did you find that you and your team members behaved according to your stated types? You were asked to**

**suggest potential problems that might occur because of the particular mix of personality types. Did any of these problems become apparent to you?**
*This is a cognitive apprenticeship question related to cooperation but also a judgment question related to understanding of self and others and the interactions between people.*

Overall
This analysis applies to both UGs and PGs. The great majority of students believed that their team got on reasonably well (with one or two exceptions). In the absence of conflict most students took the view that there was no need or purpose in trying to understand the team dynamics. It could be that the questions as framed (highlighting problems) may have suggested the viewpoint that if there was no problem then looking at personality types and their interaction was unnecessary. The analysis of interactions by students was generally intuitive in nature and there was little or no attempt to use Myer Briggs as means of understanding how or why their team operated the way it did. I believe that there are several reasons for this. Firstly, a significant number of students didn't disclose their Myer Briggs types to other team members so these students couldn't effectively address the questions. Secondly, nearly all students who made an attempt at analysis using Myer Briggs typically didn't go beyond distinguishing between introverts and extraverts. With hindsight it seems clear that students didn't have enough knowledge of and insight in using Myer Briggs to do this analysis in an effective way. In spite of the fact that all students appear to have their opinions about their own personality type and that of personality of other team members, there is possibly also a lack of interest or scepticism by many students regarding the idea that people can or should be "typed". Since this analysis, while I have kept the material on Myer Briggs in reduced form as a means of self-analysis in the belief that it is useful to understand one's own personality traits and appreciating that others are different and how they might be different, I now include some material directly related to team dynamics (Belbin team roles) in lectures which concentrates on the various roles that team members play in teams. I believe this team role material is easier to understand and much easier to apply and interpret in small teams.

## Question 11 Value of the learning environment

**As you think over your own personal and professional development this semester during the project, how useful did you find the environment that was set up this semester with its group discussions, presentations and supervisor guidance? Considering the learning environment and resources as a whole, what do you believe was the most valuable aspects for you? Were there any negatives?**

*This is a cognitive apprenticeship question on the effectiveness of the discussions and overall environment of the subject. It is also trying to gauge the importance of the various aspects of the cognitive apprenticeship environment. The amount of time spent on or the number of words written about some aspect mentioned in answer to other questions of the project environment may not be a true reflection of their importance to them.*

### Overall

Given the general nature of the set of questions the responses were quite varied and not easy to classify into sub-themes.

UGs were generally positive in their overall evaluations with 45% giving positive comments, only 10% giving a negative comment and the rest not providing a comment either way. In contrast the PGs 15 (83%) gave positive comments. Positive comments were that as follows:

*"[the unit] has been personally the most enjoyable unit I have studied and I believe it due to the professional nature and environment of the unit. I really enjoyed the structure of the unit.*"

"*good learning experience*" ,

"*the environment was setup quite well; my personal development throughout the semester was a good one*",

"*the environment was excellent, relaxed and laid back it wasn't intimidating, which is often the case for a lot of groups and lectures*",

"*there are no negatives I can think of*",

"*Overall it was a positive experience. It was great to be in a professional environment and having to work on an actual real problem. Also, it was rewarding that something you are working on would maybe be considered to be used in the real world*";

"*Overall, I found the environment to be extremely effective*", "*The environment set up in CBISS was highly effective and beneficial to my personal and professional development.*",

"*The environment was friendly and full with technology*",

*"I … like the environment set up in this semester because it gives us a taste of how the real workplace operates and the environment*",

A negative comment from an UG student was that he "*found the environment very restrictive and inhibitive*" and believed that "*the report could have been completed in a much shorter time-frame with much better quality results*" if they had been provided with detailed marking criteria (for the report and presentation) and "*free access to the client*". This student also stated that writing of journals was not helpful and neither was any self or team evaluation as they were both "*a massive distraction from the main report*".

With regard to the meeting room setting, the space itself was organised in an open plan with cafeteria style tables and chairs around which teams could sit and talk with each table having four permanently situated laptops. There were white boards around the room and as well as projection facilities for presentations. The setting was positively commented on and generally students appreciated a common time set aside for teams to meet.

With regard to timing of events such as lectures and discussions, three (15%) UG students would have preferred more structure but only one student offered an explanation of what was meant: "*the unstructured nature of the subject made matters somewhat difficult; the seemingly random lectures and meetings with clients made it hard to concentrate on the project when other subjects required constant attention.*" My interpretation of this comment was that other units had a regular weekly pattern of lectures, tutorials and so on with pre-set assignment deadlines while the project was, in comparison, rather chaotic with intermittent lectures provided as needed and client interviews that occurred on the basis of client availability rather than planned and scheduled at the beginning of semester. The work demands of the project unit were "lumpy" and relatively unpredictable and some students, not surprisingly, found this unsettling.

Lectures were appreciated by a few (15%) UGs as quite valuable,

*"The group discussions and presentations were great, and provided an opportunity to talk to your team and learn valuable skills from the presentations."*

Another stated

*“The resources provided; Report writing guide, Myers Brigg test, effective Interviewing, the nature of experience, effective presentations and the paper on the consultation process, to be excellent materials that delivered great value to the learning experience”.*

On the other hand, two students (10%) stated that this material had already been covered in earlier units of study and so was unnecessary.

Supervisor meetings were specifically mentioned by 55% of UG students as valuable or the most valuable aspect of the environment while 28% of PGs mentioned this. As one student put it, *“The most valuable aspects of the project were our direct communications with our supervisor, [supervisor name]. His previous experience in project and team management was invaluable in assisting me and our team with their understanding of the project.”*

Other aspects of supervisor meetings mentioned as important related to understanding their project, keeping on track, and getting team and personal feedback.

Having group interviews with clients was regarded as negative by 3 (15%) students and positive by one (5%). The lack of control in directing questions seemed to be a major issue together with the expectation that if the project had been exclusively allocated to the particular student’s team then the clients would have been available for more time and at the students’ convenience. 22% of PG students commented that they appreciated the client interviews. There were no negative comments from PGs.

Lessons learned included how to handle a project, having a good process, building credibility, being organised, carrying out tasks in a thorough manner and appreciating different perspectives of students, clients and supervisors.

## Question 12 Final thoughts

**Any other thoughts?**

### Overall

Some concluding student comments:

*“I think the subject was an educational experience and I am glad to at least have had the chance to work on it.”*

*“The project has been a rewarding and satisfying experience and thanks to [two supervisors] for a fantastic unit in my final semester.”*

*“I really enjoyed this experience and have developed as a professional.”*

*"All in all, [this unit] has been a challenging yet a decent experience for my last semester at university. I believe my experience from this subject have, to some extent, given me an insight on how a real group work operates in a real world project/scenario. Thanks [expert P] for supervising our project and giving feedback when needed and thanks Gil for giving us directions throughout the semester."*

*"I will not forget the lessons learned in this subject."*

# APPENDIX D – ETHICS

## Introduction

A copy of the original documentation related to obtaining and receiving ethics approval is provided in this appendix as required by Swinburne University.

# Original Application

SWINBURNE UNIVERSITY OF TECHNOLOGY

HUMAN RESEARCH ETHICS COMMITTEE

**APPLICATION FOR ETHICS APPROVAL of a RESEARCH PROTOCOL**

| Date Received ........................ |
|---|
| HREC No:......... |

## SECTION A: GENERAL INFORMATION

**[Nb This application form should not be used for research involving clinical trials or ionising radiation.** See below.**]

| | |
|---|---|
| **PROJECT FULL TITLE** | The Application of Cognitive Apprenticeship as applied to learning in Information Systems education |
| SHORT TITLE (If applicable) | Cognitive Apprenticeship in IS education |
| **APPLICANT DETAILS** | |
| **RESPONSIBLE SWINBURNE FIRST INVESTIGATOR / SUPERVISOR** (Where project is part of student research degrees or dissertations, Senior Swinburne Supervisor must still be listed as the first investigator) | **Name & Title/Position: Dr Adi Prananto**<br>Tel No(s) 9214 5003<br>Email: aprananto@swin.edu.au Fax<br>Faculty / School / Centre / Institute: FICT.........................................<br>Swinburne Status: ☒ Swinburne Staff Member ☐ Adjunct Staff Member<br>Address for correspondence: H39, Faculty of ICT, Swinburne University of Technology, John St, Hawthorn, 3122 |
| Please complete as clearly as possible. (For Honours, higher degree and discrete student projects.) | **Main Student Investigator(s): Gilbert Ravalli**<br>Email gravalli@swin.edu.au Tel No(s) 9214 8440<br>Student ID Number 9314121 Fax<br>Degree Being Undertaken: Doctor of Philosophy |

List below the names of other Chief/Associate Investigators and Research Assistants (including those with access to identifiable data).
(Add (copy/paste) cells as required for additional investigators/assistants. Append Student lists for class projects.)

| | |
|---|---|
| **Name & Title: Assoc Prof Greg Heath** | |
| Institutional Address: Australian Catholic University | Tel No(s) 5336 5300 |
| **Name & Title/Position:** | |
| Institutional Address: | Tel No(s) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Proposed Period During Which Human Research Activity Requiring Ethics Approval is Needed:** | **From** 01 *dd* | 03 *mm* | 2010 *yyyy* | **to** | 31 *Dd* | 12 *mm* | 2011 *yyyy* |

*[Double-click on ☐ YES/NO 'check box' to select box, then enter Default Value as Checked ☒ or leaving as Not Checked ☐ ]*

| | | |
|---|---|---|
| TYPE OF ACTIVITY (Select as many boxes as applicable) | ☒ Research by Staff Member<br>☒ Supervised Postgraduate Research | ☐ Contract Research (Attach copy of contract)<br>☐ Supervised Undergraduate Research |
| | ☐ Supervised Class Projects: No of students involved:<br>Subject Code & Short Title: | |

**Broad Category of Research**
Select one category box which best fits the application:
☐ Social/Cultural/Humanities ☐ Business/Management ☒ Education/Training/Program

Human Research Ethics Committee Page 1
*(Aug 2004. Form amended August 2007)*

Evaluation
☐ Psychological/Brain/Neuro-sciences ☐ Health/Safety ☐ Engineering/Science/Technology
☐ Other (please specify) ……………………………………………………

[** For research involving **Clinical Trials or Ionising Radiation**, please contact the Research Ethics Officer.]

*Official Use Only:*
☐ **Higher Risk/Impact** ☐ **Minimal Risk/Low Impact Research Only**
☐ ***SUHREC*** ☐ ***SHESC (HBS - A / B)*** ☐ ***SHESC (SBT - A / B)*** ☐ ***Other*** ☐ ***Notification Only***

**Human Research Risk/Review Classification** (Nb Checking to be consistent with published risk criteria.#)
To enable a determination as to whether prima facie your research activity is Minimal Risk and/or Low Impact, please clarify by selecting [X] any one or more boxes below as to whether your research activity involves:

*[Double-click on ☐ YES /NO 'check box' to select X by entering in Default Value as Checked ☒ or leaving as Not Checked ☐]*

| | |
|---|---|
| ☐ Vulnerable participants, children or those dependent on care* | ☐ Indigenous Peoples* or Special Cultural/Ethnic groups |
| ☐ Externally funded research requiring HREC-level clearance* | ☐ Multi-centre/Other sites requiring HREC-level approval* |
| ☐ Research conducted overseas | ☒ Conflicts of interest or dual researcher-professional roles |
| ☐ Data access/use without an individual's prior consent* | ☐ Data access/use subject to statutory guidelines &/or reporting* |
| ☐ Identification of participant individuals/groups in research outcomes without full consent or there is unclear consent for this* | |
| ☐ Sensitive information/issues vis-à-vis context/impact (legal*, regulatory compliance*, commercial, professional, cultural, etc) | |
| ☐ Personally intrusive/confronting or quite inconvenient/embarrassing questioning or other activity | |
| ☐ Physically confining/invasive techniques or significant physical contact/stimulation (TMS*, X-ray*, CT scan*, MRI*, clothing change, etc) | |
| ☐ Working in hazardous environments (asbestos dust*, infectious disease*, war or civil strife*, etc) | |
| ☐ Handling hazardous substances (eg, asbestos*, radioactive material* , explosives*, etc) or equipment | |
| ☐ Administration of medical/herbal substances*/treatments* | ☐ Administration of other (non-medical) substances/treatments |
| ☐ Health/medical diagnosis*/therapy* | ☐ Non-minimal impact therapeutic or other devices*/activity* |
| ☐ Screening for healthy participant inclusion/exclusion | ☐ Medical or psychiatric assessment/conditions* |
| ☐ Serious psychological profiling, investigation or exploration | ☐ Withdrawal of treatment/services or use of placebo |
| ☐ Withdrawal/substitution of educational/professional/commercial/recreational/other programs or services | |
| ☐ Deception or covert observation | ☐ Limited or non-disclosure of research information/procedures |
| ☐ Participant recruitment/selection via third party | ☐ Human research activity commenced without clearance |
| ☐ Participation incentives, prizes or significant payments | ☐ Research placing researchers/assistants at risk |

PLEASE NOTE: If you have selected any one or more of the above boxes, your project will ordinarily be put for SUHREC ethical review. Items above marked * must be put to SUHREC proper. But in other cases, you may wish to put a case for expedited review by a SUHREC Sub-Committee (SHESC) in the (expandable) box below in relation to the criteria for determining risk/impact. If you put forward a case, then in the first instance your application will be put to the relevant SHESC; however, the relevant SHESC may still consider the project needs full SUHREC appraisal or SUHREC may review or override the SHESC decision.

I wish to research the educational experience of students undertaking capstone projects in my area of Information Systems. I believe that this corresponds to the ethical category of "unequal or dependent relationships". I will be the subject convener and supervisor of teams as part of my professional duties as a lecturer here at Swinburne. Students are required to complete and submit journals describing their experiences and ideas as part of their assessment for this subject but I also wish to have access to these submissions for research purposes. Also I wish to interview one or more of the staff supervising student teams about their experiences as a team adviser and their interpretation of how students are coping and responding to their project work.

Human Research Ethics Committee Page 2
(*Aug 2004. Form amended August 2007*)

Risk/Impact Checked with a Research & Ethics Advisor (REA)? **Yes** ☐ **No** ☐ REA Comment, Initials & Date:

.............................................................................................................................................

Human Research Ethics Committee Page 3
(*Aug 2004. Form amended August 2007*)

A1 ***WHY*** IS THE PROJECT TO BE UNDERTAKEN

Summarise in sufficient detail why the project is being undertaken. If references are quoted, full citations should be given. Include the educational and/or scientific aims of the project. *(boxes will expand for your text)*

Requirements analysis and design (RAD) is a complex area which students find difficult and there is a great deal of literature which supports this view. Analysis and design subjects challenge students to think at a metacognitive level e.g. thinking about thinking and many students struggle to understand such abstract concepts (Hadjerrouit 1999; Yazici, Boyle et al. 2001; Chilton, McHaney et al. 2006). RAD is largely about defining the problem, analysis and determining the requirements and leaving implementation to others but Connolly and Begg (2006) point out that students "often have considerable difficulty comprehending implementation-independent issues". When working on real world problems, their inexperience means they may not have developed mental models of relevant aspects of business and information systems which are appropriate or sophisticated enough to assist effectively in real world RAD projects (Armarego 2002; Cope 2002; Cope 2003).

It is unlikely that their previous academic experiences have prepared them very well for real world projects. The methodologies taught in information systems courses are suitable to teach beginners but, in practice, experienced developers adapt and modify these methodologies or develop new ones as required by the project based on their expertise and experience. As well, real world projects are likely to be complex and often "characterized by incomplete, contradictory and changing requirements, and solutions that are often difficult to recognize as such because of complex interdependencies". Several authors involved in education haven noted that students "have difficulty handling ambiguity and vagueness, which can arise during knowledge elicitation". They also "have difficulty analysing problems where there is no single, simple, well-known, or correct solution". (DeGrace and Stahl 1990; Fitzgerald 1998; Connolly and Begg 2006).

Teaching approaches tend to adopt a style of teaching *about* RAD but these appear to be not very effective. For example, in the North American approach to teaching information systems related courses Connolly and Begg (2006) state, "this approach is based on a normative professional education curriculum, in which students first study basic science, then the relevant applied science, so that learning may be viewed as a progression to expertise through task analysis, strategy selection, try-out, and repetition". They go on to say that is particularly a problem in database analysis and design which is a fundamental subset of the area requirements analysis and design.

Schon (1983; 1987) makes several points about design which is relevant to teaching. Firstly, he suggests that it cannot be taught by describing the process but instead must be learned through practice. Secondly, it is a holistic skill and the parts cannot be learned in isolation. Thirdly, it depends on having an understanding of which properties are desirable and undesirable in the context of the problem space and this can only be learned by doing. Design is a creative process and as such requires seeing and doing things in new ways (Connolly and Begg 2006).

Given the arguments above, a suitably supportive learning environment is required which recognises the particular challenges and difficulties faced by students learning RAD. One such approach is that of Cognitive Apprenticeship (Brown, Collins et al. 1989; Collins, Brown et al. 1991; Collins 1993) which uses the idea of synthesizing the more traditional apprenticeship model of instruction with the teaching of more conceptual subjects in the educational environment; hence the descriptor "cognitive". They provide a general framework to guide the development of teaching using the cognitive apprenticeship approach. The framework addresses four areas: content, methods, sequencing and sociology. The area of content is broken down to domain knowledge, heuristic strategies, control strategies (also called metacognitive strategies) and learning strategies. Methods relate the possible teaching strategies which can be employed for teaching and these include, for example, modelling, coaching, scaffolding, articulation, reflection and explanation. Key features of the cognitive apprenticeship approach are the provision of learning in realistic settings, the supervision of students by someone with practical experience and recognised competency and an interactive environment of mutual dialogue in which students and supervisors try to make explicit their understanding and thought processes so that tacit knowledge and assumptions are made explicit.

The research involves providing a learning environment aligned on CA principles to students doing capstone projects requiring RAD in the information systems area. In capstone projects students are formed into teams and are involved in solving real world problems with clients from industry. This provides an appropriate context for learning about RAD. The aim of the research is to study the development of students' understanding and skills in RAD as they progress through their projects and the usefulness of the CA environment in this development. At this stage it is expected that students have sufficient knowledge and skills to appreciate and absorb what will be offered (e.g. the coaching of an expert in requirements analysis) and the setting is a reasonably realistic one where they will be dealing with "real world" clients who have problems they wish to solve that students could expect to meet in the workplace.

## A2 *WHAT* - BRIEF DESCRIPTION OF PROJECT

***In plain English***

The aim of this research is to investigate the application of professional judgement of students undertaking a requirements analysis project in a final year project unit through application of the Cognitive Apprenticeship Model. It will do so by exploring their understanding, thought processes, attitudes and approaches when dealing with a real world project. Projects are assigned to teams and some teams of students will be supervised by professional analysts who apart from supporting the teams will compare and contrast students' professional judgement with their own. From a teaching perspective the unit implements many aspects of the Cognitive Apprenticeship (CA) model of learning and the research will also explore in what ways this approach supports or assists the development of professional judgement in students.

Development of professional judgement includes the development of attitudes and approaches to situations (ways of thinking) which are appropriate to that professional area. In practical situations, not only is the relevant theoretical knowledge and skills required but one must be sensitive to the particular situation by taking into account the entire context of that situation. Context includes, but is not limited to, factors such as the organisation and stakeholders, cultural and historical factors and possible future scenarios which need to be taken into account in order to provide a satisfactory solution.

The research involves a capstone project unit (HIT3427/HIT8427 Configuring Business Information Systems Solutions) at Swinburne University. The projects undertaken by students are of one semester duration and are intended to solve real world problems proposed by industry clients. Students are formed into teams and each team is assigned a problem and a client with whom they communicate directly. Teams do not work at the client's work site although they may meet there for interviews and other discussions. All these projects are of an analytic nature and teams essentially analyse, research and provide recommendations or advice which the clients can then act upon if they so choose. Each team is appointed an academic advisor who they meet regularly (typically once each week) and who monitors and supports the team throughout the project. The research involves students and academic advisors.

## A3 *HOW* - PROCEDURES

Please detail clearly and sufficiently the proposed research/statistical method(s), procedures and instruments to be used in the project, including all screening and research 'procedures' to which the participants will be subjected, and asterisk those which may have adverse consequences.

Please include as appendices all screening instruments, questionnaires, interview protocols etc (at least in draft form if not finalised).

Because of the highly interactive nature of the researcher, its focus on problem determination and aim to improve the outcomes of students undertaking this type of capstone project unit in the future it is a form of action research. The research methodology proposed is a qualitative interpretive approach. Students will describe their thought processes, attitudes and approaches to addressing problems. Also what they do and produce will be observed and examined by their much more experienced advisors (at least one of whom will be a professional analyst). The advisors will provide their own interpretation and understanding of events by comparing and contrasting students thought processes, attitudes and approaches to addressing problems with their own. The similarities and differences observed may provide insights into how to improve education in requirements analysis both in this unit, other similar units as well as how to better prepare students in their earlier studies. At this stage some form of thematic analysis approach to analysing the data collected is proposed. Thematic analysis essentially involves analysing data to search for common themes and how they relate to each other.

***It should be noted that all students involved this subject will not notice any difference whether they participate in the research or not. There is nothing extra required of those who participate compared to those who don't. My only request is to allow me to use their submitted work for research purposes. Students who were enrolled in the previous semester (i.e. already completed) will be contacted to gain consent. Students who are currently doing the subject will be invited to participate. To avoid conflicts of interest or a potential interpretation of coercion by students when requested to participate, students will be requested for permission to use their submitted work by someone not associated with the unit and the results of those requests will only be made available to me after results for the unit published. Being a capstone project unit all students will soon be completing their course and I will not be teaching these students in the future.***

The research makes use of multiple data gathering techniques (Denscombe 2007, p37; Yin 2009, p18). The data collection methods proposed are as follows:

**Students' structured journals** – All students are required to submit journals providing their reflections regarding project work. There will be four submissions in total starting in the first week or so and roughly every four to five weeks thereafter. The journals are structured in that a number of open ended questions are posed which will also be of relevance to this research. The four journal submissions could also be regarded as a set of four thematically linked questionnaires. Journals are individual and not disclosed to other students. In order to determine students' understanding of the project and management of their project work and to be able to provide appropriate feedback, a team's supervisor is expected to read the journals of their students. To avoid a potential conflict of interest and to encourage students to be as open and honest as possible in their comments, a student's journal will not be assessed for the purpose of assigning a grade or score by their direct supervisor. (All student journal questions are provided as part of this submission)
**Student Teams Final Project Report and other submissions** – Teams are required to submit documents relating to the project at various times. These include interview questions and interview summaries, background documents describing the client's organisation and role, presentations slides and each team's final report. The final report outlines the client's problem, some background information which places the problem in context, outlines the process undertaken in researching the problem, finding appropriate solutions and final recommendations. Students will be asked for their permission (as relevant) to use these documents for my research. (These are not provided with this submission but copies of all previous submitted team reports, interviews are available on request and are normally kept (securely) as required by Swinburne University)
**Interviews with project team advisors** – One or more experienced requirements analysts will participate as project team supervisors during the semester. Those concerned will be employed by Swinburne University in a tutor role. They will be interviewed regarding their observations of the students under their supervision but also to gain insight into their perspectives about requirements analysis. Sets of interview questions have been formulated as a basis for what will be discussed in interviews with supervisors but discussions may deviate somewhat from proposed depending on what is found at the time. (Proposed interview questions are provided as part of this submission)
**Student evaluation reports** – the standard reports that students volunteer to submit to Swinburne University at the end of each semester. Individual students are not identifiable by me in these reports.
**Observation** – My own observations and interpretations of events will form part of the research

If you feel that it is necessary to include further material, please append.

## A4 DESCRIBE ANY RISK THAT MAY ARISE TO THE PARTICIPANT / DONOR?

*Risk to participants (and to researchers) can be real but does not need to be physical. Risk includes such as self esteem, regret, embarrassment, civil or criminal liability, disease, physical harm, loss of employment or professional standing, etc. Please consider such possibilities carefully*

*Some research activities may put the* participant *at risk through what is being done or simply through their participation.*

Please describe the risk you perceive and the protective measures to be taken.

Note, as previously mentioned above, that students are not being asked to provide any additional thoughts or comments or input in any way beyond what is required as part of their assessment in this unit.

I believe the questions being asked of students in their journals are not particularly intrusive or personal in nature since they focus on aspects of the project that students are involved in. Some questions may be uncomfortable since they question their understanding about a situation, extend them into aspects that they may not have considered before or ask about their working relationships with other team members. No deeply personal information (e.g. personal problems, health problems, family, disabilities etc) is requested. It is hoped that students will feel free to criticize whoever and whatever they wish related to the project and subject. Questions are posed in a relatively neutral way and not specifically designed to encourage negative sentiments or attitudes. The consent form specifically requests students to *not* reveal anything that they might later regret or be embarrassed by. The same applies to academic advisors in their interviews.

Journals in particular are regarded as confidential and are electronic submissions secured in a password protected environment. Any printed copies made will be kept secure and destroyed after use. The same regimen applies to any interviews with supervisors. No participants (individuals or organisations) will be identified in any published work. If there was a situation in which individuals or the organisation might be traceable (and there is no intention for this to be the case), the participant would be able to review that part of the work and, if needed, the material will be deleted or modified to accommodate their concerns.

The focus of the research is on students and to the person(s) acting as team advisors. While the students deal with external clients and their organisations these are peripheral to the research and will only be referred to in so far as they provide a context that will aid in understanding the students' experiences. As examples, it will be enough to indicate a type of industry (e.g. an educational institution, a not-for-profit organisation, software developer) whether a small, medium or large organisation (indicative for example of the amount of bureaucracy or formality that might be involved in business processes) or to describe clients' role and general background knowledge (e.g. an administrator with a business degree but without a strong understanding of IT). The particular organisation or client should in no way be traceable. There will be no reference to any confidential material related to the clients or organisations. With that in mind, it is believed that consent forms were *not* required to be obtained from the clients or the organisations concerned.

## A5 DESCRIBE ANY RISK THAT MAY ARISE TO THE RESEARCHER / ADMINISTRATOR?

*Some research activities may put the researcher at risk through what is being done or simply through their participation.*

Please describe the risk you perceive and the protective measures to be taken.

No risks perceived

## A6 WHAT BENEFITS ARE ANTICIPATED FROM THE PROJECT

Ethical principles would require that benefits flowed from the activities - but please avoid grandiose claims.

(a) To the Participant (what and how so)

Implementing aspects of the cognitive apprenticeship framework can provide a rich and reflective environment from which learn about the requirements analysis and design process. Documents from previous work performed by students are provided as guidance so that students can see what they need to do while lectures on group dynamics, presentation skills, report writing build on what they already know. Academic advisors expect students to be proactive in their project but then challenge and question them about what they have done or propose to do. When guidance or advice is provided by supervisors the reasoning behind that should also be provided so that students can understand the purpose and limitations of that advice which potentially gives them something (in terms of attitudes or ways of thinking) at a deeper level that they can potentially use later in their career.

The journal questions that students answer are intended to help students reflect about what they are doing and learning as they work on their project. In my opinion, unstructured journals (or more recently blogs) where students write about what is of interest to them are limited in their usefulness because they tend to display and, perhaps to a small degree extend, what students already know or ways they view the world. To develop professional judgment one needs to be challenged to think beyond one's existing ideas and ways of thinking. The structured questions in these journals are intended not only to display or extend students existing ideas but, by addressing a wide variety of ideas and different levels of abstraction, take them into areas that students may not have considered before or considered in depth. For students, the journals' aims are to:

- help them become aware of what they do and do not know.
- connect prior knowledge and skills with the project that they are working on.
- summarize their knowledge and encourage insight into understanding.
- develop their critical thinking skills
- help them to organise their thoughts

For supervisors, the encouragement to discuss, question, explore and debate with students and other supervisors in the wide variety of projects involved may provide new insights into students' thinking and perhaps to questions their own thinking about requirements analysis and design.

(b) More generally (to society, profession, knowledge, understanding, etc, and how so.)

Insights into students' development of professional judgment in requirements analysis and design projects and potentially how better to teach and organise these types of projects.
Insights into students' understanding of aspects requirements analysis and design and potentially how to better teach these aspects.
A better understanding of the criteria relevant to effective analysis skills and how we can better teach those skills to later students doing IS courses.
Although this study is conducted in the area of requirements analysis and design in Information Systems, a number of other areas which have design as an important aspect of their work (e.g. engineering and architecture amongst others) may find some useful ideas and approaches.

## A7 POTENTIAL PROBLEMS

*From time to time in the course of a research project important information, such as an individual found to be at risk, or entirely unforseen events may come to pass.* What procedures are in place to handle unexpected or particularly significant personal or other

Human Research Ethics Committee — Page 9
(*Aug 2004. Form amended August 2007*)

information that may come to light through the project, eg, unknown medical/psychiatric condition, a particularly distressed participant, civil or criminal liability, etc.

> Given that this research is based around students enrolled in a unit of study at Swinburne University, all the normal procedures that would be followed for any student will apply. If medical, psychiatric conditions were discovered or if a participant were distressed then the student(s) involved can be directed to the support services provided by the university if that was appropriate. If there were actions discovered that might lead to civil or criminal prosecution, these actions would be reported to the appropriate authorities within the Faculty of ICT for advice and possible action.
>
> Should information (including personal journals) become available the most serious consequences I can envisage is some minor embarrassment.

## A8 PROFESSIONAL/ETHICAL ABILITY & TRAINING (Researchers/Students/Assistants)

NS 1.15 Research must be conducted or supervised only by persons or teams with experience, qualifications and competence appropriate to the research … using (appropriate) facilities … (and with appropriate skills and resources for dealing with any contingencies…

(a) Sufficiently detail what investigators/assistants will do in this project and their expertise/competence to do so.

> The researcher is a permanent member of staff with an Honours Degree in Physics, a Diploma in Education, a Diploma in Mathematical Science, a Master of Applied Science by Research and 20 years teaching experience at Swinburne University in the higher education area. He also has two research supervisors who have a great deal of expertise in interpretative research to act as guides in the areas of Information Systems and Education. He has been studying the research methods concerned and attending seminars provided by the faculty on these.

(b) Sufficiently detail any further training/qualifications required for investigators/assistants to carry out the project.

> I am still studying and trying to improve my skills through further reading, discussions with supervisors and attending relevant research seminars being held. In the meantime, the educational resources and teaching instruments which are also research resources are being developed, trialled and refined.

## A9 FUTURE USE OF DATA

Will any of these data be used by yourself, your students or others for any purpose other than for this project as described in the protocol? If so please describe.

> No.

## A10 EXTERNAL INVOLVEMENT

Is a body external to Swinburne involved in initiation or support of the project?

☐ Yes Name of body/organisation. ..............................................................................

If an external body is associated with the project you **must** provide the HREC with detail of the arrangements, *including details of any funding or other resources being provided.* A copy of relevant pages from the contractual arrangements should be attached.

☒ No

## A11 EXTERNAL APPROVALS

Projects involving other organisations or entities may require approval from other institutions or their ethics committees, etc. for such things as access to prospective participants, contact lists, data, facilities, etc. A copy of such approvals may be required to be provided to the HREC at the time of application or be made available as soon as possible. In which case, the project may not commence, until such evidence is provided.

Please indicate, as appropriate, if formal clearance/permission has been obtained or sought:

Institutional Yes ☐ Documentation Attached ☐ or to follow ☐

Next of Kin (for special groups) Yes ☐ Documentation Attached ☐ or to follow ☐

(estimate when likely to be obtained)

☐ No (please explain)

Human Research Ethics Committee Page 10

(*Aug 2004. Form amended August 2007*)

**A12 RESEARCHER / SPONSOR RELATIONSHIP**

Is there any relationship or association between the sponsor and any of the researchers listed in Section A of this form, for example are any of the researchers directors, officers, employees, shareholders or promoters of the sponsor or do they receive any personal benefits from the sponsor under any other contracts or arrangements?

☐ No

☐ Yes (please explain the relationship(s), including how a vested or a conflict of interest situation does not arise. )

| |
|---|
| |

## SECTION B: ETHICAL ISSUES OVERVIEW

### B ETHICAL ISSUES

*[Double-click on ☐ YES/NO 'check box' to select box, then enter Default Value as Checked ☒ or leaving as Not Checked ☐ ]*

| | | YES | NO |
|---|---|---|---|
| (a) | Non-/Limited Disclosure or Deception: Is any detail in relation to research purposes, methods or questions being withheld from participants? Or will deception of any kind be involved? Or any covert/undeclared observation? (Refer *National Statement* Chap 17) | ☐ | ☒ |
| (b) | Does the data collection process involve access to confidential personal data (including access to data provided for a purpose other that this particular research project) without the prior consent of subjects? | ☐ | ☒ |
| (c) | Will participants have pictures taken of them, e.g., photographs, video recordings?<br>If "YES", please explain how you intend to retain confidentiality and ultimately dispose of the material. | ☐ | ☒ |
| (d) | If interviews are to be conducted, will they be record by electronic device?<br>If "Yes", please explain how you intend to retain confidentiality and ultimately dispose of the material. | ☒ | ☐ |
| (e) | Will participants be asked to perform any acts or make statements which might compromise them, diminish self esteem or cause them embarrassment or regret (minimal, moderate or significant)? | ☐ | ☒ |
| (f) | Might any aspect of your study reasonably be expected to place the participant at risk of criminal or civil liability (not just immediately or directly)? | ☐ | ☒ |
| (g) | Might any aspect of your study reasonably be expected to place the participant at risk of damage to their professional/social/cultural/financial standing or employability? | ☐ | ☒ |
| (h) | Will the research involve access to data banks subject to privacy legislation?*<br>*(NOTE: Annual reporting to Government may be required on this item. For info: please contact the Research Ethics Officer.)* | ☐ | ☒ |
| (i) | Will participants come into contact with any equipment which uses an electrical supply in any form e.g., audiometer, biofeedback, electrical stimulation, magnetic stimulation, etc.? If "YES", please outline below what safety precautions will be followed. | ☐ | ☒ |
| (j) | Will any treatment be used with potentially unpleasant or harmful side effects? | ☐ | ☒ |
| (k) | Does the research involve any stimuli, tasks, investigations or procedures which may be experienced by participants as stressful, noxious, aversive or unpleasant during or after the research procedures? | ☐ | ☒ |
| (l) | Will the research involve the use of placebo control conditions or the withholding/substitution of treatment, programs or services (health, educational , commercial, other)? | ☐ | ☒ |
| (m) | Will any samples of body fluid or body tissue be required specifically for the research which would not be required in the case of ordinary treatment? | ☐ | ☒ |
| (n) | Will participants be fingerprinted or DNA "fingerprinted"? | ☐ | ☒ |
| (o) | Are there in your opinion any other ethical issues involved in the research? | ☐ | ☒ |

**NOTE**: If the answer to any of the above questions is "yes", please **explain** and **justify** below in sufficient clear detail. (The box below will expand to fit your response.)

(d) interviews recordings with the person(s) acting as academic advisors(s) will be stored on a password protected drive and which can be deleted once transcribed or of no further use.

Attach further documents if appropriate

Human Research Ethics Committee
*(Aug 2004. Form amended August 2007)*

Page 12

## SECTION C: PARTICIPANT DETAILS

### C1 PARTICIPANT DETAILS

*The composition of the participant group may, in some circumstances, distort and invalidate an outcome, and risks may arise through the composition of the participant group.*

How many individual participants will be involved? *(Number/number ranges for which approval is sought)*

Males: [ ] Females: [ ] Total participants [30]

Over what range of ages?

From (youngest): [20] To (Oldest): [40's ?]

If there is a gender or age imbalance in the number of participants please explain why.

Will depend on the student cohort doing projects in a particular semester and who volunteers. There tends to be a significantly greater number of males in the IS area so this may well be reflected in the number of volunteers participating.

### C2 RECRUITMENT

How will participants be recruited/selected?

*Please outline the process in sufficient detail how this is to occur.*

***Note**: Where participants are obtained from or through schools, hospitals, prisons or other institutions, appropriate institutional or other authority will probably be needed. If soliciting for participants by advertisement or poster please attach proposed copies or text.*

*(See also Project Information Consent Statements and Signed Consent Forms info at the end of this application form.)*

All students enrolled in my project unit (Configuring Business Information Systems Solutions) are potential recruits. I will invite students to participate in the research at the beginning of the semester.

Suitably qualified requirements analysts will be invited to volunteer as academic advisors.

### C3 PRE-EXISTING CONDITIONS

*In some situations an underlying medical or other significant condition of a participant may result in an otherwise relatively innocuous situation causing excessive stress and exacerbate the condition. Researchers must, therefore, be alert to such situations and be able to address the resulting issues.*

Do participants have any medical or other significant condition of which you are aware, eg. diabetes, asthma, depression, epilepsy? What steps are in place to handle any resulting problems (you may need to correlate with A3, A4 and A7 of this form)?

NA

### C4 DISCLOSURE AND INFORMED CONSENT

How will participants be informed about the project in order to give valid consent:

- ☒ Consent Information Statement(s)/Letter(s) and Signed Consent Form(s) will be used.
  *A copy must be attached to your application. A guide to consent instruments is given at the end of this form.*
- ☐ Consent Information Statement(s)/Letter(s) and consent implied by return of anonymous questionnaire
- ☐ Verbal advice (Please explain how and why)
- ☐ Other (Please explain how and why)

**Copies of appropriate consent instruments must be attached to your application.** Please consult the Guide to Human Research Informed Consent Instruments in carefully preparing informed consent instruments.

### C5 COMPENSATION

Consent to participate must be freely given and not induced through the level of reward, perceived reward, or power relationships

Provide details of any financial or other reward or inducement is being offered to subjects for participation. Indicate the source of the funds.

Human Research Ethics Committee Page 13
(*Aug 2004. Form amended August 2007*)

| |
|---|
| None |

## C6 RELATIONSHIP TO INVESTIGATOR(S)

Free consent may be difficult to ensure if the participant is dependent upon the investigator for employment, assessments etc

*Some relationships cause special ethical issues to arise*

Are participants linked with the investigator through some particular relationship - eg. employees ultimately responsible to or superiors of the investigator, students of investigator, family members, friends etc.

| |
|---|
| Some students will have been taught by the researcher in a previous subject (e.g. Requirements Analysis and Modelling) since this is a mandatory subject in several courses. I do not teach any of the subjects that students may be doing concurrently with the project subject. This being a capstone project subject it is unlikely that I will ever teach these students again. |

## C7 INVOLVEMENT OF SPECIAL GROUPS

Particular issues of consent may arise where special groups of participants are to be involved. There may be, for example, a need to obtain informed consent from persons other than the direct participant. Examples of such special groups include special cultural groups - eg. indigenous Australians; children and young persons (Guidelines section 4.2); groups with special circumstances - eg. persons with an intellectual or mental impairment (Guidelines s. 5)

Please identify and describe the nature of the groups and procedures used to obtain permission.

*Note. Persons proposing research projects involving Indigenous Australians should consult with the relevant University manager of indigenous programs prior to finalising definition of the project.*

| |
|---|
| None |

## C8 PRIVACY

*The University is subject to the Victorian Information Privacy and Health Records Acts as well as the Commonwealth Privacy Act and, in particular, the Information/Health/National Privacy principles (IPPs/HPPs/NPPs) set out therein and is required to report annually on projects which relate to or utilise particular records.*

Does the research involves access to data which was collected by an organisation for its own purposes (ie. not specifically collected for this project) such as student records, other data banks, human pathology or diagnostic specimens provided by an institution/s?

If yes, please indicate source/s.

| |
|---|
| Possibly. Student Satisfaction Survey of units conducted by Swinburne University of Technology as part of their normal may be referred to if this is relevant and interesting. |

## C9 LOCATION OF STUDY

Please indicate where the research will be carried out. If the research will not be on University premises permission of owner / occupier may be required. If so, please indicate what authority or permission may be required and how will be obtained. ***NB**: Where required, please attach to this application evidence of authority obtained or provide the Secretary, HREC as soon as practicable.*

| |
|---|
| Swinburne University of Technology (Hawthorn Campus) |

## SECTION D: DATA & PUBLICATION ARRANGEMENTS (Nb Section D Revised Aug 2007)

PLEASE CONSIDER CAREFULLY YOUR RESPONSES TO THIS SECTION. YOU NEED TO BE CLEAR AS TO WHAT IS OCCURING WITH RESPECT TO DATA COLLECTION, RETENTION and DISPOSAL.
(In your responses, you should demonstrate familiarity with National Statement requirements for confidentiality, relevant Privacy Principles and Swinburne's *Policy on the Conduct of Research*, eg, Sect 4, see URL:
http://www.swinburne.edu.au/corporate/registrar/ppd/docs/PolicyontheConductofResearch.pdf).

### D1 DATA COLLECTION/RECORDING (Nb Section D1 Revised Aug 2007)

Please note that, with any information or data collected/retained, if any individual can reasonably be identified, the information can be deemed "personal information" or "health information" under National/Health/Information Privacy Principles (NPPs/HPPs/IPPs).

(a) How or in what form will **data** be collected/recorded?

*(eg, notes; verbatim, audio and/or video recordings; transcriptions of recordings; recorded or signed consents; etc)*

> Students will submit journals and other project related documents during the teaching semester. These are submitted electronically via the submission systems provided by the University (e.g. the digital dropbox in Blackboard).
>
> Interviews with team supervisors will be electronically recorded and/or notes taken.

(b) As regards **any individual**, in relation to any data collection or retention, you need to acknowledge either or both of the following:
*[Double-click on ☐ 'check box' to select X by entering in Default Value as Checked ☒ or leaving as Not Checked ☐]*

☒ **An Individual can be identified OR is Potentially Identifiable / Re-Identifiable**

*(An individual can be identified at some point or by the very nature of the data collected/retained: at time of an interview, by signed consent form, identified or labelled voice or image recording, pen-and-paper questionnaire, on-line survey instruments, etc.*

*Whilst data may not have (explicit) identifiers, an individual's identify can still reasonably be worked out.*

*Or data may have (explicit) identifiers removed and replaced by codes that permit matching of an individual with the data collected/retained, in which case it is possible to identify or re-identify the person to whom the data relates.)*

☐ **An Individual is Non- or Un-identifiable**

*(Data collected/retained anonymously and with no reasonable possibility of being identified.)*

Your acknowledgement may require further explanation or clarification; if so, please include in the following box.

> An individual or organisation will be identifiable using the original raw data.

### D2 DATA SECURITY (Nb Section D2 Revised Aug 2007)

Please note that "data must be held for sufficient time to allow reference. For data that is published this may be for as long as interest and discussion persists following publication. It is recommended that the minimum period for retention is at least 5 years from the date of publication but for specific types of research, such as clinical research, 15 years (or more) may be more appropriate." (Sect 4.3 of *Swinburne's Policy on the Conduct of Research*)

Please indicate **how data** (all types of data, including, eg, signed consent forms) **will be securely retained** (eg, electronic form in password-protected disk drive, locked filing cabinet, etc) **and where**? With more than one type of data, will the types be separately stored?
In your explanation, you will need to make clear **how due confidentiality and/or anonymity will be maintained**.

(a) During the study

> Password protected disk drive with appropriate state of the art firewall and antivirus software.

(b) Following completion of study

> Password protected disk drive with appropriate state of the art firewall and antivirus software.

## D3 PUBLICATION/OUTPUT (Nb Section D3 Revised Aug 2007)

Please explain in sufficient detail:

(a) What, if any, publication (conference, news media, academic journal, other journal, etc) is envisaged following on or in relation to this project, both in terms of data proper and/or analysis of data?

(b) Will participants be informed about any envisaged research publication/outcome? (This information is normally to be included in the information given prior to obtaining informed consent.)

(c) Would any participants be able to be identified through the publication of data proper or research findings? If so, explain why this is necessary.

> (a) Academic journals, conferences
>
> (b) Students are almost certain to have finished their course and departed by the time the research is completed and any papers published so it is unlikely that I would even be able to contact them. I may still be in touch with anyone who had acted as an academic advisor so I would inform them of any potential or actual publications.
>
> (c) No.

## D4 INDIGENOUS ISSUES

Storage arrangements for data relating to research into Indigenous matters must be determined in compliance with the Policy on the Conduct of Research after consultation with the communities involved.

What consultation has taken place and what arrangements have been made.

> Not applicable.

## D5 OTHER ISSUES (Nb Section D5 Revised Aug 2007)

Are there any other issue relating to data collection, retention, use or disclosure which the ethics committee should be made aware of and, if so, please explain how you are to deal with this.

(Eg, Research outcomes unduly impacting on any individual or group not directly participating, etc.)

> No

Human Research Ethics Committee Page 16

(Aug 2004. Form amended August 2007)

## SECTION E: SUBSTANCES & CLINICAL ISSUES

☒ ***No*** matters in this section are applicable to the study *or*

### E1 ADMINISTRATION OF SUBSTANCES/AGENTS

| | | |
|---|---|---|
| Name of substance(s) | | |
| Dosage per administration | | |
| Frequency of administration | | |
| Total amounts to be administered | | |

Anticipated effects:

***NOTE***: *If the research involves administration of foreign substances or invasive procedures, please attach a statement accepting responsibility for those procedures by a medical or paramedical practitioner with Indemnity insurance.*

☐ STATEMENT ATTACHED

### E2 BODY FLUIDS OR TISSUE

What fluids or tissue? How will be samples be obtained?

Frequency and volume

How are samples to be stored?

How will samples be disposed of?

Who will take the samples?

What are their qualifications for doing so?

Do participants carry, as far as you know, the Hepatitis B or HIV virus? If so how will the risks be handled

Do participants carry, as far as you know, any other contagious diseases or viruses? If so how will the risks be handled

Human Research Ethics Committee
(*Aug 2004. Form amended August 2007*)

Page 17

## SECTION F Declarations for Signature 1 2 3

**1.** With respect to this project, **I / We, the undersigned Investigator(s)/Assistant(s) agree**:

- **To undertake human research activity or handle data confidentially in accordance with Swinburne requirements, including any standard or special ethics clearance conditions, under the proper direction of the responsible Swinburne manager and/or principal Swinburne (or other) researcher/supervisor.**

| NAME: (block letters) | SIGNATURE: | DATE: |
|---|---|---|
| Adi Prananto | | |
| Gilbert Ravalli | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

All listed applicants must sign. The Chief Investigator/Supervisor is also responsible for personnel subsequently joining the project. Expand this table or duplicate this page as required. NB This information is subject to Swinburne or external audit.

****** Please note that ******
**PROJECTS MUST NOT COMMENCE WITHOUT PRIOR WRITTEN APPROVAL from the Human Research Ethics Committee (SUHREC) or its appropriate Subcommittee (SHESC)**

**2. Declaration of Compliance by Chief Investigator(s)/Student Supervisor(s).**

I declare that the above project has been developed and will be conducted in accordance with relevant Swinburne standards, policies and codes of practice, including any standard or special conditions for on-going ethics clearance. I further declare that all listed and subsequently appointed researchers or assistants involved in this project will be made aware of the conditions of ethics approval as communicated to me, including approved documentation and procedures.

Signature & Date: ....................................................................................................

Name of Signatory & Position: ....................................................................................................

(Optional) **Form checked by a Research & Ethics Advisor (REA)? Yes** ☐ **No** ☐ REA Initials & Date: ..............................

**3. Endorsement of Head of Academic Unit (or Delegate) or Above.**

I declare that this project: has been developed and will be conducted in accordance with relevant Swinburne standards, policies and codes of practice; and has research merit, adequate resourcing and appropriate leadership/supervision.

Signature & Date: ....................................................................................................

Human Research Ethics Committee (*Aug 2004. Form amended August 2007*) Page 18

| | |
|---|---|
| Name of Signatory & Position: | ................................................................................................ |

*(Please note: This endorsement must be given by an authorised official who is **not** also a chief or co-investigator of the project and who is not also the supervisor of a student investigator with an interest in the project.)*

## References

Armarego, J. (2002). Advanced Software Design: a Case in Problem-based Learning. 15th Conference on Software Engineering Education and Training (CSEET02).

Brown, J. S., A. Collins, et al. (1989). "Situated cognition and the culture of learning." Educational Researcher **18**(1): 32- 42.

Chilton, M. A., R. McHaney, et al. (2006). "Data Modeling Education: The Changing Technology." Journal of Information Systems Education **17**(1): 17-21.

Collins, A. (1993). Design Issues for Learning Environments. Technical Report Series, Centre for Technology in Education.

Collins, A., S. B. Brown, et al. (1991). "Cognitive apprenticeship: Making thinking visible." American Educator **15**(3): 4- 46.

Connolly, T., M and C. E. Begg (2006). "A Constructivist-Based Approach to Teaching Database Analysis and Design." Jounal of Information Systems Education **17**(1): 43-54.

Cope, C. (2002). "Educationally Critical Aspects of the Concept of an Information System." Informing Science **5**(2): 67-79.

Cope, C. (2003). "Educationally Critical Characteristics of Deep Approaches to Learning about the Concept of an Information System." Journal of Information Technology Education **2**: 415-427.

DeGrace, P. and L. H. Stahl (1990). Wicked problems, righteous solutions, Yourdon Press.

Denscombe, M. (2007). The Good Research Guide for small-scale social research projects, McGraw Hill Open University Press.

Fitzgerald, B. (1998). An Empirically-Grounded Framework for the Information Systems Development Process. Proceedings of the International Conference on Information Systems.

Hadjerrouit, S. (1999). A Constructivist Approach to Object-Oriented Design and Programming. 4th Annual SIGCSE/SIGCUE Conference on Innovation and Technology in Computer Science Education (ITiCSE'99), Cracow, Poland.

Schon, D. (1987). Educating the Reflective Practitioner: Towards a New Design for Teaching in the Professions. San Francisco, Jossey-Bass.

Schon, D. A. (1983). The Reflective Practitioner: How Professionals Think in Action. New York, Basic Books.

Yazici, S., T. Boyle, et al. (2001). Towards a multimedia learning environment for object oriented design. 2nd Annual Conference of the LTSN Centre for Information and Computer Sciences, London.

Yin, R. K. (2009). Case Study Research, Sage Publications Inc.

SWINBURNE UNIVERSITY OF TECHNOLOGY

**Consent Information Statement for Student (2010-08-19)**

**Project Title**
The Application of Cognitive Apprenticeship as applied to learning in Information Systems education

**Investigators**
Gilbert Ravalli

**Introduction to Project and Invitation to Participate**
This research project is about implementing and evaluating a particular approach to teaching and learning based around a concept called Cognitive Apprenticeship. This is an invitation to participate in the research by allowing me to use the work submitted by you and your team members.

**What this project is about and why it is being undertaken**
Requirements analysis and design (RAD) is complex and difficult. There are important factors suggested for this. Firstly, many students are being taught about things with which they have little or no experience and so while they may have theoretical knowledge and skills it is difficult for them to see when and how best to apply these ideas in practice. Secondly, those teaching in areas related to RAD may know how to apply it but may not be able to explain or present what they do in a way that students can fully understand. Finally, there are some things you just have to experience to understand – no amount of explaining can bridge the gap.

The subject that you now enrolled in is intended to provide you with a learning environment that will expose you to real world problems, clients and context. You will have by now a great deal of academic knowledge related to information systems you probably will have little knowledge of how to apply it effectively to solve problems in practice.

The aim of this research project is to investigate the development of students' professional judgement in this subject so that we can get a better idea of the difficulties, misunderstandings and what students just don't know about when they are starting to work on real world problems. There are several ways we intend to find out the information we need. The first way is by getting you to fill out journals with specific questions at several points during the semester. These journals aim to explore what you understand, what you are doing in your project and what you believe to be important to get the job done. Another source of information is through the documents that are produced by students during the project.

It is hoped that by gathering and analysing all this information we can improve our understanding of the difficulties and challenges involved in student team projects at this level and use that to improve this subject and other similar ones in the future.

**Project interests**
This project is being conducted solely towards the degree of Doctor of Philosophy conducted at Swinburne University of Technology.

**What participation will involve**
There is nothing extra required of you since, whether you choose to be involved or not, everyone does exactly the same tasks as everyone else i.e. there are no extra forms, interviews, discussions etc requested if you decide to become involved.

**Participant rights and interests**
I do not see any significant risks to students. You will be doing what you would normally do as a student. No-one will be requested or expected at any time to do, say or write anything that they might find embarrassing or that they might later regret. If any work is published as a result of this research, participants and organisations will *not* be identified.

From your perspective it is hoped that the teaching and learning environment provided will be an enriching one and that you will develop significantly in your professional skills.

Human Research Ethics Committee Page 21
(*Aug 2004. Form amended August 2007*)

**Free Consent/Withdrawal from Participation**
You are asked to volunteer by *signing the consent form*. You may withdraw at any time by contacting the person who distributed the consent form. I will not know who has or has not consented until results have been submitted at the end of the semester so there should no feeling that any student is going to be punished or favoured by participating or not.

**Participant rights and interests – Privacy & Confidentiality**
All submissions and with regard to this project subject are considered confidential and no person or organisation will identified in any published works.

All data will secured electronically in a password protected environment with high quality firewall and antivirus software.

**Research output**
It is intended that there will be papers published in journals or conferences. Any paper which results from this research will be available to any of the participants on request.

**Further information about the project – who to contact**
If you would like further information about the project, please do not hesitate to contact:

Dr Adi Prananto
Faculty of ICT
Hawthorn
Swinburne University of Technology
Location: EN514C
Phone: 9214 5003
Email: aprananto@swin.edu.au

**Concerns/complaints about the project – who to contact:**

This project has been approved by or on behalf of Swinburne's Human Research Ethics Committee (SUHREC) in line with the *National Statement on Ethical Conduct in Human Research*. If you have any concerns or complaints about the conduct of this project, you can contact:

Research Ethics Officer, Swinburne Research (H68),
Swinburne University of Technology, P O Box 218, HAWTHORN VIC 3122.
Tel (03) 9214 5218 or +61 3 9214 5218 or resethics@swin.edu.au

**Swinburne University of Technology**

**Project Title:** The Application of Cognitive Apprenticeship as applied to learning in Information Systems education

**Principal Investigator(s): Gilbert Ravalli**

1. I consent to participate in the project named above. I have been provided a copy of the project information statement and this consent form and any questions I have asked have been answered to my satisfaction.

2. ***Please circle your response to the following:***
   - I agree to allow the use my individual submissions (e.g. journals, background documents, etc.) for research purposes **Yes No**
   - I agree to allow the use of my team documents (e.g. report, interview notes etc.) for research purposes **Yes No**

3. I acknowledge that:
   (a) the risks have been explained to me to my satisfaction;
   (b) my participation is voluntary and that I am free to withdraw from the project at any time without explanation;
   (c) the project is for the purpose of research and not for profit;
   (d) any personal information about me which is gathered in the course of and as the result of my participating in this project will be (i) collected and retained for the purpose of this project and (ii) accessed and analysed by the researcher for the purpose of conducting this project;
   (e) my anonymity is preserved and I will not be identified in publications or otherwise without my express written consent.

By signing this document I agree to participate in this project.

**Name of Participant:** ………………………………………………………………………

**Signature & Date:** ………………………………………………………………………………

Human Research Ethics Committee Page 23
(*Aug 2004. Form amended August 2007*)

SWINBURNE UNIVERSITY OF TECHNOLOGY

**Consent Information Statement for Team Supervisors (2010-08-19)**

**Project Title**
The Application of Cognitive Apprenticeship as applied to learning in Information Systems education

**Investigators**
Gilbert Ravalli

**Introduction to Project and Invitation to Participate**
This research project studies the development of professional judgment in students involved in an information systems capstone project conducted within a Cognitive Apprenticeship teaching framework. This is an invitation to participate in the research by allowing me to obtain and record your observations and insights regarding the professional judgement of students that you will be advising during the conduct of students' projects.

**What this project is about and why it is being undertaken**
Requirements analysis and design (RAD) is complex and difficult. There are important factors suggested for this. Firstly, many students are being taught about things with which they have little or no experience and so while they may have theoretical knowledge and skills it is difficult for them to see when and how best to apply these ideas in practice. Secondly, those teaching in areas related to RAD may know how to apply it but may not be able to explain or present what they do in a way that students can fully understand. Finally, there are some things you just have to experience to understand – no amount of explaining can bridge the gap.

It is suggested that more interactive approaches to teaching and learning roughly based on an apprenticeship style of learning may be effective in teaching in RAD. The Cognitive Apprenticeship approach has many aspects but the main ones are that it gets students to do realistic work (like industry projects) and that it emphasises lots of explanation and reflection among the students and instructors so as to better understand and share knowledge.

It is hoped that by trying out some of the features of this approach in this subject and studying how they work we may improve our understanding of the difficulties and challenges involved in student team projects. We hope that this can then improve this subject and other similar ones.

**Project interests**
This project is being conducted solely towards the degree of Doctor of Philosophy conducted at Swinburne University of Technology.

**What participation will involve**
The cognitive apprenticeship approach will be explained and the supervisor asked to be aware of and support as best they can the principles related to interacting with student teams.

The researcher will interview you at three different key points within the semester to obtain your observations and insights regarding (i) how students are managing and progressing with their particular projects based on your own experience as an analyst and (ii) how the teaching environment supports students' development of their professional judgement and how the environment might be improved. If you are not available for interview or it is not convenient then you will asked to fill out questionnaires instead.

**Participant rights and interests**
I do not see any significant risks to supervisors. You will act in a normal way expected as a team supervisor subject to all the obligations and constraints in your teaching role required by Swinburne University of Technology. You (and your assigned students) will not be requested or expected at any time to do, say or write anything that you (or they) might find embarrassing or that you (or they) might later regret.

As a team supervisor you may enjoy working with a team of students and helping them to develop their analytical skills. This process may, perhaps, help you to become more aware of and improve your own skills.

**Free Consent/Withdrawal from Participation**
You may withdraw at any time. Your support is gratefully accepted in any case.

**Participant rights and interests – Privacy & Confidentiality**
All submissions with regard to this project are considered confidential. Any work published (e.g. in a journal or at a conference) will not identify the individuals or organisations involved.

All data will secured electronically in a password protected environment with state of the art firewall and antivirus software.

**Research output**
It is intended that there will be papers published in journals or conferences. Any paper which results from this research which involves your contribution will be made available to you for comment and any concerns will be addressed prior to submission for publication.

**Further information about the project – who to contact**
If you would like further information about the project, please do not hesitate to contact:

Dr Adi Prananto
Faculty of ICT
Hawthorn
Swinburne University of Technology
Location: EN514C
Phone: 9214 5003
Email: aprananto@swin.edu.au

**Concerns/complaints about the project – who to contact:**

This project has been approved by or on behalf of Swinburne's Human Research Ethics Committee (SUHREC) in line with the *National Statement on Ethical Conduct in Human Research*. If you have any concerns or complaints about the conduct of this project, you can contact:

Research Ethics Officer, Swinburne Research (H68),
Swinburne University of Technology, P O Box 218, HAWTHORN VIC 3122.
Tel (03) 9214 5218 or +61 3 9214 5218 or resethics@swin.edu.au

**Swinburne University of Technology**

**Project Title:** The Application of Cognitive Apprenticeship as applied to learning in Information Systems education

**Principal Investigator(s): Gilbert Ravalli**

1. I consent to participate in the project named above. I have been provided a copy of the project information statement and this consent form and any questions I have asked have been answered to my satisfaction.

3. ***Please circle your response to the following:***

| | | |
|---|---|---|
| ▪ I agree to be interviewed by the researcher | **Yes** | **No** |
| ▪ I agree to allow the interview to be recorded by electronic device | **Yes** | **No** |
| ▪ I agree to make myself available for further information if required | **Yes** | **No** |
| ▪ I agree to complete questionnaires if interviews are not convenient for me | **Yes** | **No** |

3. I acknowledge that:
   (a) the risks have been explained to me to my satisfaction;
   (b) my participation is voluntary and that I am free to withdraw from the project at any time without explanation;
   (c) the project is for the purpose of research and not for profit;
   (d) any personal information about me which is gathered in the course of and as the result of my participating in this project will be (i) collected and retained only for the purpose of this project and (ii) accessed and analysed by the researcher(s) for the purpose of conducting this project;
   (e) my anonymity is preserved and I will not be identified in publications or otherwise without my express written consent.

By signing this document I agree to participate in this project.

**Name of Participant:** ......................................................................................

**Signature & Date:** ....................................................................

## Journal 1 – Initial Thoughts

What do you hope to get out of doing this project subject?

Assume you have an upcoming interview with the project manager of some upcoming but as yet unknown projects. The manager will be asking you about your three strongest points in terms of knowledge or abilities about yourself? What would they be?

The same manager also will ask you about your weaknesses with a view to helping you to improve in these areas or putting you with colleagues who can compensate for your weaknesses. What do you see as your biggest weaknesses or the aspects that you most want to develop?

The project requires a great deal of teamwork. What has been your experience with regard to working in teams in the past?

What do believe your lecturer or supervisor will expect you to demonstrate in your future project?

What do believe your future client will expect from you and your team? How is this different from what is expected by your supervisor?

## Journal 2 – Problems, requirements and strategies

While dealing with your client, what were your observations about them and the workplace culture?

How successful was the first interview? What were you using to measure success? Did the interview go as expected and if not what was different to your expectations?

Describe what you perceive to be the business problem and the vision of how things will be different assuming the problem is solved. To what extent do you believe that the project you are working on is realistic and of importance to the client? How relevant or interesting is the project to you?

Control strategies are things you do that determine if you are on track and, if not, to diagnose what the problem might be and help you to get you back on track. What control strategies do you have in place to ensure that you understand the problem, have an appropriate scope and that requirements are correct, comprehensive and measurable?

Having done the Myer Briggs test what is your suggested personality type? Does it appear to be substantially correct for you? If not, where does it appear to be incorrect? Was it helpful to you in any way to do this test?

Compare yourself with your team mates across the four dimensions of E/I, S/N, T/F and J/P. Describe the potential problems that might arise given your particular mix of personality types. Are there any strategies that you might use to overcome these problems?

Team members need to agree on the project goals, standards and generally about how the team members operate. To what extent do you believe that your team has this agreement?

Human Research Ethics Committee
(*Aug 2004. Form amended August 2007*)
Page 29

What management and control strategies does your team have in place to ensure that you will finish on time, that all members have share the workload fairly and that work is of an acceptable standard?

By now you should have looked at some reports by previous project groups as well as other materials provided to assist you. You should have a reasonable idea as to what has to be done and standards to be achieved. How well do you believe you understand what you have to do in your project and the standards that will be applied? If your understanding seems poor or mediocre then what is concerning you?

Do you believe that you have learned something new or are learning anything significantly new from *your other team members*? What are these? These might be ideas or facts but they may also relate to attitudes, perspectives or ways of doing things related to communication, teamwork, leadership, organisational skills academic skills etc. Consider also that you might also be learning something by observing what appear to be others' mistakes, poor attitudes etc.

The meetings held each week with your academic supervisor and fellow team members are intended to encourage discussion to clarify ideas, highlight problems, suggest problem solving strategies and generally share ideas and viewpoints between the team members as well with the supervisor. What have been the most important outcomes from these discussions for you since the last journal?

Are there any tasks or issues that your supervisor assisted you with outside the weekly discussions? If not then skip to the next question. If yes then what were they? Would you still need assistance if the same task was required in future or do you believe you could handle it okay by yourself (you alone or with your team members).

Is there anything that you believe could have been improved up to this point or could still be improved for the remainder of the semester?

Any other thoughts?

## Journal 3 – Researching and finding solutions

Describe the and extent of your communications with your client organisation since your last journal. In what way(s) have they been productive? If not, what do you see as the problem(s)?

Has there been any significant change in your understanding of the client's problem description and requirements in your project? If there have been significant changes what do you attribute this to? If there have been significant changes, with hindsight do you believe that you could have better determined these requirements at the beginning or not? If so, how? If not why not?

Control strategies are things you do that determine if you are on track and, if not, diagnose what the problem might be and helping to get you back on track. At this stage, these will relate to researching for possible solutions and finding the most satisfactory solutions which meeting the requirements and hence to solving the problem. What control strategies do you have in place to ensure that your research and solutions will be satisfactory?

How well are your management and control strategies working to ensure that you will finish on time, that all members have fairly share the workload and that work is of an acceptable standard?

How would you judge the team interaction at this stage? Whether it is good, bad or indifferent why do think it is going this way? Can you relate this to the interaction of your different personality types (from the Myer Briggs test) or something related to the small group communications work covered earlier this semester or something else?

What do you perceive as being your major contribution(s) to your team and (hopefully) the success of your project so far (for example, attention to detail, creativity, organisational skills, leadership, communication skills etc)? Is there anything (a role or task) that you wish you could do better?

Since your last journal submission, do you believe that you have learned something new or are learning anything significantly new from *your other team members*? What are these? These might be ideas or facts but they may also relate to attitudes, perspectives or ways of doing things related to communication, teamwork, leadership, organisational skills etc. Consider also that you might also be learning something by observing what appear to be others' mistakes, poor attitudes etc.

The meetings held each week with your academic supervisor and fellow team members are intended to encourage discussion to clarify ideas, highlight problems, suggest problem solving strategies and generally share ideas and viewpoints between the team members as well with the supervisor. What have been the most important outcomes from these discussions for you since the last journal?

Since the last journal, are there any tasks or issues that your supervisor assisted you with? If so what were they? Would you still need assistance if the same task was required in future or do you believe you could handle it satisfactorily by yourself (or with your team members). Do you think that this assistance could have been provided in a better or different way?

Is there anything that you believe could have been improved up to this point or could still be improved for the remainder of the semester?

Any other thoughts?

| |
|---|
| |

## Journal 4 – Final Reflections

What were your aims in your final presentation? In what ways did it go particularly well or badly? Any there any aspects which you wish you had done differently or better in preparing for the presentation?

To what extent did you provide input into the final report? Did you feel that you understood what was required? What difficulties did you encounter either personally or from the perspective or coordinating and refining the work of the team members?

The meetings held each week with your academic supervisor and fellow team members are intended to encourage discussion to clarify ideas, highlight problems, suggest problem solving strategies and generally share ideas and viewpoints between the team members as well with the supervisor. What have been the most important outcomes from these discussions for you since the last journal?

Since the last journal, are there any tasks or issues that your supervisor assisted you with? If so what were they? Do you think that this assistance could have been provided in a better or different way? Would you still need assistance if the same task was required in future or do you believe you could handle it okay by yourself (you alone or with your team members).

What stands out to you as some of the more important principles or values that your supervisor has emphasized to you about projects like these? These may have been stated explicitly (i.e. directly in words) or they may have been implicit (i.e. not stated in words but implied through their attitudes or value judgments).

Human Research Ethics Committee
(*Aug 2004. Form amended August 2007*)

Page 36

Reviewing previous subjects you have done e.g. Systems Acquisition and Implementation Methodologies, Business Intelligence, Requirements Analysis and Modelling, Enterprise Systems, Process Modelling, Project Management what theories, knowledge, skills or processes did you find most relevant and appropriate to apply this project? (If you have many things that you could mention, just mention the ones that seemed most important to you)

At which point in the project (if ever) did you feel that you understood what you were trying to achieve and how to get there? If you did, was there anything in particular that helped you with this or did your prior knowledge and experience make it obvious to you? If this understanding didn't come till the end or still is not there even now, what aspects didn't or don't you feel sure about?

There will always be something new or different about each project. What new (or extension of existing) knowledge or skill have you had to acquire in the project that hasn't been taught in previous subjects? If so what was it? Was there anything that you believe is missing, not covered sufficiently well or not emphasized enough that would have prepared you better for the project?

Now that the project is over, what do you think would be the key bits of advice you would give to beginning project students or you might apply in your next project?

In Journal 2 you were asked to consider your personality type and that of your team members according to the Myer Briggs test and think about potential problems that might occur in your group as a result. Did you find that you and your team members behaved according to your stated types? You were asked to suggest potential problems that might occur because of the particular mix of personality types. Did any of these problems become apparent to you?

Human Research Ethics Committee Page 37
(*Aug 2004. Form amended August 2007*)

As you think over your own personal and professional development this semester during the project, how useful did you find the environment that was set up this semester with its group discussions, presentations and supervisor guidance? Considering the learning environment and resources as a whole, what do you believe was the most valuable aspects for you? Were there any negatives?

Any other thoughts?

## Response to ethics committee questions

*1. A1: Research question needs to be clearer – what subject is to be surveyed? The survey and focus groupvquestions needs to be thought through more clearly to answer the research question (see also 10 and 11 below);*

- Students of the subjects listed in (5) below will be surveyed regarding their experiences with group work projects. The survey will ask them questions about their group work experiences. The survey will ask them questions about peer-assessment. The subject to be surveyed is group work and peer assessment.
- Volunteers from the subjects listed in (5) will be asked questions in a focus group regarding their experiences with group work projects. During the focus group they will be asked questions about their group work experienced. During the focus group they will be asked questions about peer assessment. The subject for which data will be collected during the focus group will be group work and peer assessment.

*2. A9: Answered incorrectly. Question is asking about further use of data, for instance is the research*
*part of a bigger study etc. In this instance, Researcher can leave answer as "No" and delete remaining text;*

- No

*3. B(d): Please justify recording device. Please provide the specific location for the data and explain how long the tapes will be stored;*

- The focus groups will be recorded via a Digital Voice Recorder (DVR). The voice recording is required to allow clear transcriptions made at a later date. This is important as up to 6 students are expected to attend each focus group making note-taking alone ineffective to capture all of the data and difficult for the Research Assistant who will also be facilitating the focus groups. The audio files will be transferred by the Research Officer from the DVR to the H: belonging to and only accessible by the Research Officer. The audio files will then be deleted from the DVR. At the completion of the research process, the Research Officer will double-delete (delete from H: and delete from trash) all audio files, All participants will be informed of this process in the Information Statement (Appendix C).

*4. C1: Researcher needs to complete this section;*

- Male = 18 Female = 18 Total = 36 (6 x 6 groups)

*5. C2: Please identify the groups or classes involved;*

- The students targeted will be those enrolled in:
  - HIT3061
  - HIT3416
  - HIT3427
  - HIT8071
  - HIT8427

*6. C4: Verbal Advice box is checked – explanation as to how and why is needed;*

- This was ticked in regards to "participants being informed [verbally] about the project", but perhaps not "in order to give valid consent". This box should be unticked.

*7. Need Consent Information Statement for the survey;*

- This was provided as Appendix C. Please also find attached to this email.

*8. D1(b): Please explain data collection procedures, including coding to preserve confidentiality;*

- The data will be collected on a Digital Voice Recorder by the Research Officer and transcribed also by the Research Officer. The Research Officer, who will also facilitate the focus groups, will code the participants during transcription. Participants will be coded by focus group and a number. Participants of the first focus group will be coded A1, A2, A3, A4 etc. Participants of the second focus group will be coded B1, B2, B3 etc., and so on for following focus groups.

*9. D2(b): Please provide more information on location;*

- Any notes or tapes will be locked in the Research Officers office. The audio files from the DVR will be kept on the H: of the Research Officer, which is only accessible by the Research Officer.

*10. Appendix A (Survey Questions): Subcommittee needs to see finalised version including 'Options'. In addition to the general comment made at (1. above) please note the following:*

*(i) third last question is doublebarrelled – this needs revising;*

- Questions revised to:
  Which of these two options do you prefer and why? a) Everyone in a group receives the same mark. b) Marks are distributed to each individual member based on his or her contribution.

*11. Appendix B (Focus Group Questions): Subcommittee needs to see finalised version. In addition to the general comment made in (1. above) please note the following:*

- 

*(i) fonts are not consistent throughout document,*

- The focus group questions have been formatted into a consistent font throughout the document.

*(ii) under GROUPWORK last three questions are not open ended,*

- These questions have been changed to:
  - How fair was the distribution process?
  - How fair was the distribution of actual tasks?
  - What was the decision of distribution based on?

*(iii) please explain what is meant by FEEDBACK/CONTRIBUTION GOAL.*

- Students may not be aware of what may be considered a reasonable amount of time to undertake a particular task. This question refers to one of two methods considered to provide a guide for students. One option is to provide **feedback** *after* a task has been completed. The feedback can be provided on the amount of time they did take to complete a task. This would be provided if a task took longer than may be considered reasonable. Alternatively, the **contribution goal** can be provided *before* the task is undertaken. The student then has a goal which they can work toward in regards to the amount of time they spend on their contribution to the project.

# Ethics clearance

**From:** Ann Gaeth
**To:** Prananto, Adi; Ravalli, Gilbert
**CC:** Resethics
**Date:** 22/10/2010 4:45 PM
**Subject:** SUHREC Project 2010/196 Ethics clearance

To: Dr Adi Prananto FICT; Mr Gilbert Ravalli,

Dear Dr Prananto and Mr Ravalli,

**Re: SUHREC Project 2010/196 The application of cognitive apprenticeship as applied to learning in information systems education**
Dr Adi Prananto FICT Mr Gilbert Ravalli, A/Prof Greg Heath
Approved duration 22/10/2010 To 22/10/2012 [Adjusted]

**I refer to the ethical review of the above project protocol undertaken by a SUHREC Subcommittee (SHESC3). Your responses to the review, as e-mailed on 21 October 2010 with attachments, were approved inline with the guidelines set by a SUHREC delegate(s).**

I am pleased to advise that, as submitted to date, the project may proceed in line with standard on-going ethics clearance conditions here outlined.

- All human research activity undertaken under Swinburne auspices must conform to Swinburne and external regulatory standards, including the current National Statement on Ethical Conduct in Research Involving Humans and with respect to secure data use, retention and disposal.

- The named Swinburne Chief Investigator/Supervisor remains responsible for any personnel appointed to or associated with the project being made aware of ethics clearance conditions, including research and consent procedures or instruments approved. Any change in chief investigator/supervisor requires timely notification and SUHREC endorsement.

- The above project has been approved as submitted for ethical review by or on behalf of SUHREC. Amendments to approved procedures or instruments ordinarily require prior ethical appraisal/ clearance. SUHREC must be notified immediately or as soon as possible thereafter of (a) any serious or unexpected adverse effects on participants and any redress measures; (b) proposed changes in protocols; and (c) unforeseen events which might affect continued ethical acceptability of the project.

- At a minimum, an annual report on the progress of the project is required as well as at the conclusion (or abandonment) of the project.

- A duly authorised external or internal audit of the project may be undertaken at any time.

Please contact me if you have any queries about on-going ethics clearance. The SUHREC project number should be quoted in communication. Chief Investigators/Supervisors and Student Researchers should retain a copy of this email