An Empirical Study of the Effects of Conscientiousness in Pair Programming using the Five-Factor Personality Model

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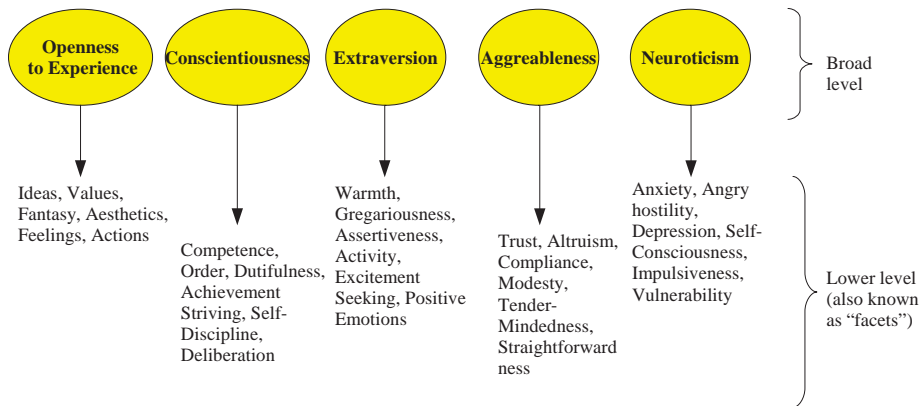- Results & Discussion
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Introduction

- Pair Programming (PP) - two people working together side-by-side on the same set of design/coding tasks.
- PP is reported to be beneficial for improving students' learning outcome.
- Many studies have investigated factors affecting PP's success for education purpose. One such factor is personality.
- Our study is looking at the effects of personality trait conscientiousness on the effectiveness of PP.
- Conscientiousness is most closely linked to determination, or will to achieve, and reported as the strongest predictor of academic performance.

Related Work & Motivation

- Many studies have been conducted to understand the effects of personality in PP; Our SLR showed that studies' findings were inconsistent.

- Most PP studies used Myers-Briggs Type Indicator (MBTI) to measure personality.

- Our motivation is to investigate personality on PP's effectiveness using the FFM.

- Why FFM? It is widely accepted by personality psychologists as a robust taxonomy of personality and relevant to the educational context.

- Literature in Psychology support conscientiousness as important trait related to academic success and team performance.

The Five Factor Model (FFM)

"Big Five" traits

Openness to Experience → Ideas, Values, Fantasy, Aesthetics, Feelings, Actions

Conscientiousness → Competence, Order, Dutifulness, Achievement Striving, Self-Discipline, Deliberation

Extraversion → Warmth, Gregariousness, Assertiveness, Activity, Excitement Seeking, Positive Emotions

Aggreableness → Trust, Altruism, Compliance, Modesty, Tender-Mindedness, Straightforwardness

Neuroticism → Anxiety, Angry hostility, Depression, Self-Consciousness, Impulsiveness, Vulnerability

Broad level

Lower level (also known as "facets")

Formulation of Hypotheses

- Level of conscientiousness (High/Medium/Low) indicates the degree of aspiration for achievement.
- Conscientiousness is reported to be positively associated with students' academic performance (Busato et al.,2000, Poropat, 2009).
- Teams comprising a higher average score of conscientiousness demonstrated better job performance (Barrick et al, 1998).
- We predicted that levels of conscientiousness may have effects on PP's effectiveness.

Formulation of Hypotheses

- Null hypotheses:
  Differences in conscientiousness level do not affect the effectiveness of students who pair programmed.
- Alternative hypotheses:
  Differences in conscientiousness level affect the effectiveness of students who pair programmed.

The Formal Experiment

- The formal experiment was conducted during semester 1, 2009 at The University of Auckland.
- Subjects: Undergraduate students enrolled in an introductory programming course
- Purpose: To improve the effectiveness of PP as a pedagogical tool in HE institutions.
- Focus: To investigate the influence of conscientiousness factor that can potentially affect the success of the PP practice in CS/SE courses/tasks.
- Obtained ethics approval - UAHPEC.

Variables & Design

- Independent variable: Level of conscientiousness.
- Dependent variable: PP's effectiveness and satisfaction level
- PP's effectiveness measured using assignments, a midterm test and final exam scores. Satisfaction was measured using a five-point likert-scale questionnaire.
- "Single factor between-group design" was the experimental design.

Research Settings & Instruments

- Personality data were gathered at early semester using the IPIP-NEO.
- Pairs were allocated based on the scores on the conscientiousness traits (between 0 and 99).
- Level of satisfaction working with the partner - measured using a questionnaire.

| Scores	Lowest 40%	Middle 30%	Highest 30%
Level	Low	Average	High

Experimental Procedure

- Experiment was held in weekly compulsory tutorial.
- Every tutorial lasted for two hours - 45 minutes explanation, 75 minutes for exercises.
- After "pair-jelling" period of 30 minutes, students swapped their roles.
- Before end of tutorial, students filled out a questionnaire to rate their feedback.
- Exercises given during tutorial remained the same throughout the week.

Results - Demographics

- Number of subjects enrolled: 453 first-year students (65% planned to obtain BSc.).
- 350 (74%) male students.
- Age ranged from 19 - 52 years (median $= 19$).
- 85% had no work experience.
- 218 (48%) students completed the personality test.

Results - Comparisons of performance
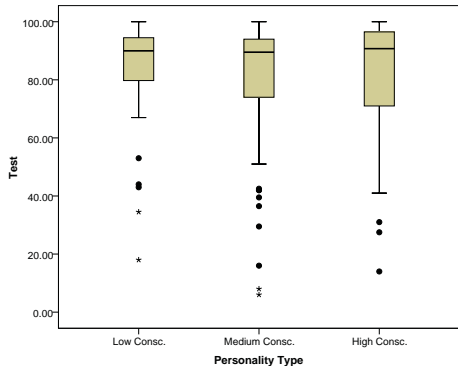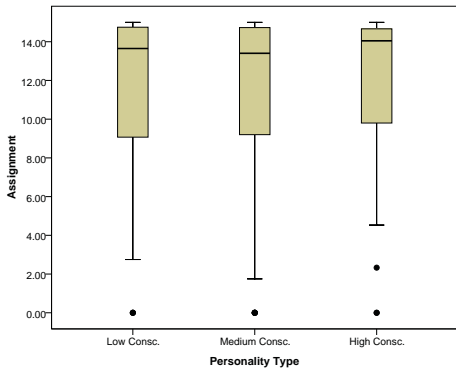
Results - Comparisons of performance
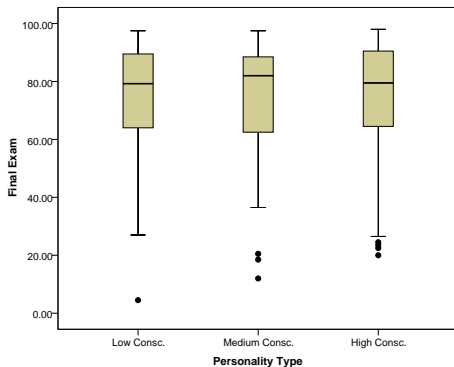
Results - Correlations between FFM and performance

	Assign	Test	Final	Extrav.	Agreea.	Consc.	Neuro.	Openn.
Assign.	1	0.43**	0.60**	0.02	-0.00	-0.03	0.02	**0.21****
Test		1	0.83**	-0.07	0.04	-0.11	-0.04	**0.13***
Final			1	-0.07	0.03	-0.08	-0.04	**0.22****
Extrav.				1	0.02	0.35**	-0.24**	0.11
Agreea.					1	0.33**	0.06	0.21**
Consc.						1	-0.14*	0.11
Neuro.							1	-0.04
Openn.								1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

- No significant relationship between conscientiousness and performance.
- The only trait showed significance relationship was openness to experience; Consistent with our previous findings.

Results - Hypotheses Testing

- Hypotheses were tested using One-Way analysis of variance (ANOVA).
- Homogeneity of variance was tested by Levene's test - samples are homogeneous.
- Result showed no significant difference between the groups.
- Thus, we could not find strong support to reject the null hypotheses.

		Sum of Squares	Df	Mean Squares	F	Sig.
Assign.	Between Groups	20.00	2	10.00	0.56	0.57
	Within Groups	3865.01	215	17.97		
	Total	3885.01	217			
Test	Between Groups	246.93	2	123.46	0.31	0.74
	Within Groups	85662.67	212	404.07		
	Total	85909.59	214			
Final	Between Groups	48.75	2	24.38	0.06	0.94
	Within Groups	86084.90	206	417.89		
	Total	86133.66	208			

Results - Satisfaction level

- Survey response rate: 67% during the first week; decrease to 42% for the final week.
- On average 90% students were satisfied working with their partner.
- Ordinal variable "satisfaction" was measured using Kruskal-Wallis test; we found no differences in terms of satisfaction levels between groups (alpha 0.05).
- Results suggested that satisfaction level of paired students were not affected by levels of conscientiousness.

Discussion

- Paired students academic performance was not significantly affected by their level of conscientiousness.
- Some studies report that conscientiousness may not always prominent in affecting performance of students teams:
  - Effects may be absent due to short period of time available to complete task (Peeters et al., 2006).
  - Low level of interdependency among team members as PP only practised for 2 hours once a week.
  - Differential effects of facets (e.g. dependability, achievement, etc.) (Le Pine, 2000)
  - University students may have tended to perform well regardless of personality attributes (Kichuk et al.,1997).

Discussion

- Of all FFM traits, Openness to experience showed the most prominent relationship with PP's effectiveness; consistent with our previous study (Salleh et al., 2009).
- Openness to experience facilitates the use of learning strategies. High openness regards to being foresighted, intelligent, and resourceful.

Threats to Validity

- Larger sample size help increase statistical power, i.e. can better detect small differences.
- Construct validity - using academic performance as surrogate measure of PP's effectiveness.
- Students may perform well due to their cognitive ability.
- Lack of control for gender effects.

Conclusions

- Results did not support our alternative hypothesis - did not provide evidence for distinguishing performance between different conscientiousness levels.
- Positive correlation between Openness to experience and all measures of PP's effectiveness; consistent with our previous study.
- Most students satisfied with the PP experience.
- Future work: investigate the effects of Openness to experience and conduct qualitative inquiry to better understand the results obtained in the present study.

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