Considerations for VR Integration into Human-Centered Computing Education

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Virtual Reality (VR) presents opportunities for Human-Centered Computing (HCC) education by facilitating immersive and experiential learning that may help students engage with complex user needs and real-world design contexts. Despite long-term interest in VR in HCC education, its integration into regular teaching practices across higher education remains limited, with a notable gap in understanding educators' perspectives on the practical considerations that influence the integration of VR into their teaching. We conducted semi-structured interviews with 15 HCC educators following a brief VR simulation using a head-mounted display and a questionnaire on demographics and prior VR experience. Using thematic analysis, our qualitative findings reveal 21 practical considerations relating to three key themes: a) technology access and provisioning, b) pedagogical considerations and c) VR design and sourcing considerations. Educators identified diverse practical considerations for effective VR integration, including equipment and tech support, health and safety, cost, instructional design, training needs, and VR content development. Our research findings offer actionable implications for computing educators and administrators to inform the planning and integration of VR-supported learning experiences, and VR designers to design pedagogically-suitable VR experiences. Our study also identified seven future research directions including the need to examine disciplinary-specific VR needs, develop decision-making frameworks for content sourcing, explore pedagogical facilitation strategies, and investigate real-world implementation dynamics in authentic classroom settings.

CCS Concepts: • **Applied Computing** → *Education*; • **Social and Professional Topics** → **Computing/technology policy**; • **Hardware** → *Emerging Technologies*; • **Human-centered computing**;

Additional Key Words and Phrases: Virtual Reality, VR Integration, Educators' perspectives

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1 INTRODUCTION

Human-Centered Computing (HCC) education emphasizes designing technologies that meet the diverse needs of users and developing software products that are usable, accessible, and aligned with real-world contexts and user goals [20, 51, 63]. This requires students to develop an in-depth understanding of users 'unlike themselves' [64] and their goals, tasks and environments [67, 71]. Yet, integrating human-centered approaches into computing education presents several challenges,

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including limited access to appropriate user groups, especially vulnerable populations [44], due to time, cost, and ethical constraints [39, 72]. In the absence of real user interaction, educators often rely on simplified proxy methods such as role-plays or mock interviews which may not capture the real-world complexity [2, 62]. Additional barriers such as busy curricula, large class sizes [57], and limited alignment with industry needs [23] further constrain effective HCC education [35, 61].

Virtual Reality (VR) is defined as "*an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment*" [32, p. 112]. Recent research highlights its potential to enhance educational outcomes related to human-centered design approaches and concepts and to address some of the challenges aforementioned [18, 36, 42]. Specifically, VR through its realistic first-person simulations [45, 46, 54] can be used to immerse users in natural, lifelike environments[48]. These experiences can be used as scalable pedagogical tools that can encourage perspective taking [75, 77] and allow people to experience the world through the eyes of others [72, 73].

Despite VR's potential and growing interest in disciplines such as health and nursing education [5, 40], teacher training [75] and other educational and training contexts [62, 77], its integration in mainstream education, including HCC education, remains limited [58, 59]. Existing studies related to VR integration in educational settings typically addresses isolated issues [10, 40, 79] such as technology, cybersickness, user experience but often overlooks key pedagogical and human-centered aspects critical to HCC education. Furthermore, these issues have not been considered collectively from the perspectives of educational stakeholders such as teachers, learning designers, and administrators [31, 34, 58] who are essential to integrating VR meaningfully within HCC curricula and teaching practices. In the context of HCC education specifically [16, 56], little is known about how educators perceive the integration of VR into their teaching, which practical considerations they may find important, and what forms of support they require.

To address this gap, our study foregrounds the notable absence of educators' voices in contemporary research on VR integration in computing education by presenting insights from fifteen computing educators teaching HCC courses. Through a qualitative examination of their perspectives, our study advances our collective understanding of the broad range of practical considerations that computing educators' perceive as important for VR integration in their teaching. The objective is that the findings from this investigation will serve as a guide for computing educators and administrators in planning and integrating VR in real-world classroom settings and enhance VR designers' creation of pedagogically suitable experiences.

2 BACKGROUND AND RELATED WORK

2.1 Addressing Challenges in HCC Education through Virtual Reality

A crucial component of HCC education involves cultivating students' capacity to engage with "users unlike themselves" [64] and understand their experiences and challenges to design technology solutions that meet their needs. However, incorporating a human-centered focus in computing education presents several practical challenges. These include difficulties in finding suitable end users, along with time, cost, and resource constraints [39]. Accessing vulnerable groups such as children, the elderly, or individuals with cognitive and physical differences often involves additional legal and ethical considerations [7, 44, 64]. In such cases, educators often rely on proxy methods, such as role-playing with peers, personas, or convenience sampling, but these offer only simplified 'demo versions' of real-world experiences [2, 62, 64].

VR offers a promising response to these challenges by enabling the creation of immersive, realistic environments through 360-degree videos, pictures, or animated scenes accessible via desktop or headsets [32]. It has been shown to improve learner motivation and engagement

[29, 58, 66] in technical and abstract domains like programming and mathematics [28], and support collaboration and teamwork in problem-based learning settings [37]. By affording qualities such as immersion, presence, and interactivity, VR creates opportunities for experiential and reflective learning [15, 45, 72]. It is particularly valuable for simulating difficult-to-access or ethically sensitive scenarios, such as remote fieldwork or interactions with vulnerable users [8]. Moreover, VR's potential to promote emotional feedback, empathy, and perspective-taking makes it especially relevant for disciplines that require understanding diverse user perspectives [42, 75]. Indeed, in HCC education, VR has been used to support design thinking by enabling ideation, simulation, and validation of user scenarios [3, 42].

Yet, although VR is increasingly being applied in computing domains such as requirements engineering, collaborative modelling, and software vizualisation [19, 65, 74], its broader integration into HCC curricula remains limited [27, 59, 70]. Nonetheless, its capacity to bridge gaps in authentic user engagement and overcome structural barriers [16, 17] positions it as a potentially powerful tool to advance human-centered approaches in computing education.

2.2 Barriers to VR Integration in Education

A range of barriers have been identified in the literature as limiting the adoption and integration of Virtual Reality (VR) in education. Cost-related and technical issues are prominent, including the high price of hardware, the development costs of immersive applications, and the need for technical expertise to build and operate VR systems [33, 58, 68]. Challenges such as setup, maintenance, and troubleshooting often require dedicated training and institutional support [25, 29, 41]. In addition, user experience limitations such as simulator sickness and physical discomfort have been reported across both K-12 and higher education settings [29, 80].

Design constraints in VR tools such as lack of realism, limited customizability, poor interactivity, and insufficient availability of scalable, context-specific content [59] further hinder integration [33, 62]. Accessibility concerns, particularly for diverse learners including children and individuals with cognitive disabilities, are also significant [22, 25, 26]. Instructional design-related factors, such as limited time, resources, and difficulty in adapting to student-centered facilitation, have been highlighted as major barriers for educators [4, 30]. Issues of teacher self-efficacy and competence to use VR are especially noted in school-level [4, 30, 78] or pre-service teacher training contexts [52].

Overall, the literature suggests that existing research tends to focus on isolated technical, student, or teacher-related issues [10, 58, 59]. However, practical aspects such as pedagogical adaptations, classroom orchestration, and administrative support remain underexplored and must be addressed collectively to realize VR's educational potential.

2.3 Underrepresentation of Educators' Perspectives in VR Integration

Educators play a critical role in the successful integration of VR into curriculum and teaching. Understanding their viewpoints, readiness, and instructional needs is key to enabling adoption [37, 59]. While some research has gathered teacher perspectives on challenges and opportunities related to VR, these have been mostly focussed on K-12 [4, 30, 78] or pre-service training contexts [52]. Carpenter et al. (2023), in a survey of 189 higher education educators, recently highlighted the need to consider both technological competence and pedagogical readiness during planning for VR adoption [17].

However, educators' experiences remain underrepresented in the literature. Radianti et al. (2020) identified a lack of studies on how VR-based teaching can be adopted in higher education curricula [58], while Calvet et al. (2019) and Khukalenko et al. (2022) emphasized the need for instructor guidelines and research into VR teaching experiences [16, 34]. Several other studies [6, 24, 56] also stress the importance of incorporating educators' perspectives for effective VR integration.

To embed VR use meaningfully in higher education, factors like teacher and student perceptions, prior experience, institutional support, and motivational barriers must be examined [6]. In the context of computing education, Pirker et al. (2020) specifically call for future research to consider teacher requirements and issues to ensure VR becomes a regular classroom practice [56]. The literature clearly reveals a gap in understanding the practical needs and experiences of educators in integrating VR for enhanced educational outcomes.

3 METHOD

3.1 Research Question and Contribution to Computing Education

Our study poses the following research question (RQ): ***What practical considerations do human-centered computing educators perceive as important for the integration of VR into their teaching and classroom practices?*** This question aims to uncover HCC educators' perspectives on the practical requirements including support and planning for effective VR integration, as well as the challenges and barriers to enable meaningful VR-supported learning.

The findings of this study contribute to the literature by expanding the focus of VR integration beyond isolated technical and individual factors to encompass a broader set of technological, pedagogical, and design considerations particularly within the context of computing education. Through a qualitative approach using semi-structured interviews, the study foregrounds the perspectives of computing educators, offering deeper insights into their practical needs and discipline-specific challenges perceived in implementing effective VR-supported teaching.

3.2 Ethics Approval and Recruitment

We obtained ethics approval to conduct the study. Participants were recruited through purposeful sampling [76], with email invitations sent to 44 educators and learning designers from our professional network, all experienced in teaching or designing computing courses with a human-centered design focus (e.g., game design, UI design, usability, accessibility, web design). The call was also shared via social media and recipients were encouraged to forward it. Interviews were scheduled as expressions of interest were received. All participants provided informed consent, were briefed on the study, and understood their participation was voluntary and could be withdrawn at any time. To protect privacy, we assigned letter-number codes to participants for data analysis and reporting. All participating educators received a gift card worth AUD 35 as a token of appreciation for their time. This monetary incentive was approved by our university's institutional review board committee.

3.3 Participants

We recruited 15 educators (12 teachers and 3 learning designers) in the field of computing education, all of whom were involved in teaching of computing courses employing human-centered approaches such as games design, user interface design, usability, accessibility and/or web design. Learning designers were included for their expertise in technology-enhanced learning and curriculum development. The educators in our study were affiliated with two higher education institutions located in south-eastern Australia (Victoria). Most participants (n=13) were aged 25–45; two were between 45–65. Eight identified as men, six as women, and one as non-binary/gender diverse. Teaching experience varied: eight had over 7 years, three had 2–4 years, and four had 1–2 years in higher education. While 12 had some prior exposure to VR through gaming or research, none had used it in teaching in last 3 years. Two educators (P8 and P12) had previously included extended reality: one via a VR guest lecturer, and another through Augmented Reality (AR), not VR. See **Appendix B** for demographics table.

3.4 Study Design and Setup

The study began with a brief questionnaire to collect demographic data and prior VR use (see previous section). Participants then engaged in VR immersion sessions (to be discussed in Section 3.5) using a VR head-mounted display (HMD) to experience a VR simulation. This was followed by a semi-structured interview to explore our research questions (Section 3.6; Appendix A). See overview of the study design in Figure 1.

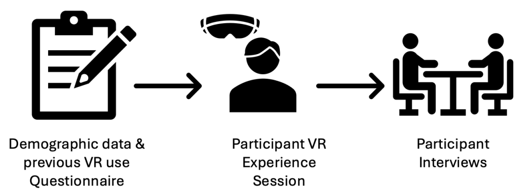

Fig. 1. Overview of the study method

Each session lasted 45-60 minutes and was conducted individually to allow for deeper, more focused discussions, free from peer influence. Interviews were adapted based on each participant's responses for a more nuanced exploration. Sessions were held in-person in a reserved room at the hosting university where the research team is based. The setup for the study included a VR headset (HTC VIVE) with two handheld controllers, a laptop for recording audio and video, table and chairs for participants, and various stationery items such as paper, colored sticky notes, pens, pencils, and markers. All interviews were audio and video recorded with participant permission for transcription.

3.5 VR Experience Sessions and Context

Before their interviews, participants engaged in a 4-minute 360° VR simulation titled "*A Walk through Dementia*", available on the YouTube channel of Alzheimer's Research UK, a leading dementia research organization in the UK. The video is designed to help viewers gain a deeper understanding of what it is like to live with dementia, offering a first-person perspective of an individual struggling with everyday tasks, making it a credible and informative resource on the condition and its challenges. Participants wore a VR headset (head-mounted display) and interacted through head movements, choosing to experience the simulation seated or standing. Hand controllers allowed them to start, pause, or exit the simulation at any time, or request researcher assistance.

3.5.1 VR experience context. To situate the VR experience in an educational context, participants were presented with a sample learning activity. They were told to imagine students using the simulation to better understand the lived experiences of users, such as people with dementia when designing technology solutions for them. This context served three purposes:

- To expose and familiarize educators with the features and pedagogical potential of VR technology.
- To provide an authentic learning context for educators to illustrate how empathy-focused VR simulations could be integrated into their coursework.
- To provide a shared reference point for educators to contextualize their discussion on the challenges and issues they anticipate in integrating VR into their teaching.

Experiencing first-person perspective of dementia may seem a non-traditional theme for computing courses, it provided a powerful, perspective-taking scenario highlighting how students might engage with end-users who differ from them in age, background, or cognitive and physical needs.

3.6 Participant Interviews

To address the RQ, we asked educators what VR integration considerations are important to them and why, what challenges or issues they anticipate with VR integration into their course teaching, and how they foresee overcoming those, and their specific support needs (see Appendix A for the full interview guide). Interviews yielded rich, contextual insights, and data collection ceased after 15 participants, once thematic saturation was reached i.e., no new concepts were emerging [50].

3.7 Data Analysis

The interview sessions were transcribed and analyzed using NVivo 12.0. We followed Braun and Clarke's inductive, reflexive thematic analysis approach to identify and report themes [12, 13], progressing from data familiarization to generating codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. Our approach centered on latent, interpretive orientation to meaning-making, moving beyond surface-level descriptions to interpret underlying assumptions, values, and contextual factors shaping educators' perspectives on VR integration.

Audio recordings were first transcribed verbatim using an automatic transcription service. The first author (primary coder) reviewed each transcript against the audio for accuracy. The research team (all three researchers) read the transcripts multiple times to familiarize themselves with the data and note initial impressions. The primary coder then conducted systematic coding, identifying segments relevant to the research questions and extracting illustrative quotes. Codes were developed inductively and refined iteratively through repeated engagement with the data. The research team met regularly to review and refine the coding structure,contributing interpretive dialogue shaped by their multidisciplinary perspectives, while final decisions remained grounded in the primary analyst's reflexive approach.

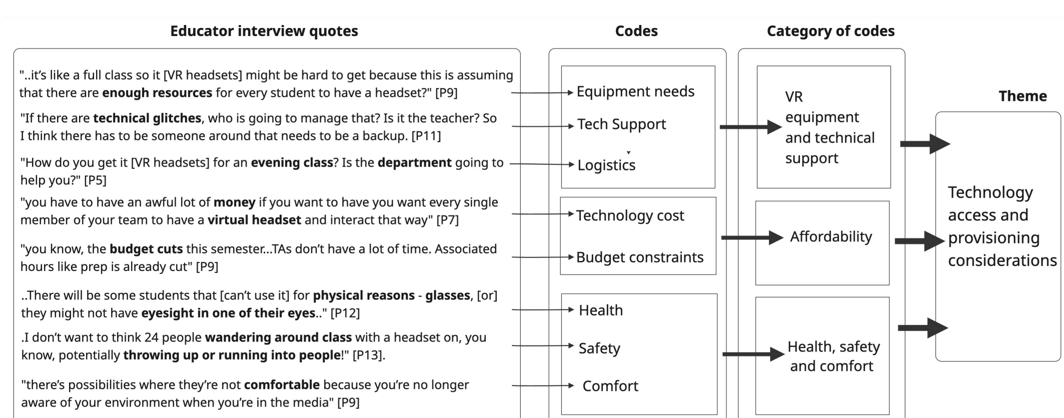

Fig. 2. Example of qualitative data analysis applied to considerations for VR integration - Educator interview quotes, codes, category of codes for the theme 'Technology access and provisioning'

We conducted a second coding round to review and group related codes into categories based on shared concepts. From these, we identified patterns and developed themes that captured meaningful connections across the data. The three researchers collaboratively examined relationships between categories and themes, refining them as needed. Throughout the process, we critically reviewed assumptions and interpretations to ensure depth and rigour. Figure 2 illustrates this process, showing how educator quotes were linked to codes, grouped into categories, and organized under themes such as 'technology access and provisioning considerations'.

After coding seven transcripts (nearly 50% of the dataset) and achieving coding stability, we conducted inter-rater reliability (IRR) testing. The primary coder and an independent coder (uninvolved in initial coding) independently coded the same transcript. Cohen's weighted kappa was 0.748, indicating substantial agreement. After reconciling discrepancies and refining code definitions, a second IRR test on a different transcript yielded a kappa of 0.91 - 'almost perfect' agreement [38]. It is to be noted that we used IRR in a limited, diagnostic way as a pragmatic tool during code development and review process [47] to complement our approach. The coding discrepancies highlighted by IRR prompted discussions of interpretations and assumptions in our multidisciplinary team, which strengthened reflexive practice within the team. Importantly, these discussions did not aim to achieve consensus but these discussions deepened our team's shared understanding of the data, improved conceptual clarity and sensitized us to alternative readings of the data, informing subsequent coding by the primary analyst, who continued to iteratively revise and deepen the analysis across all transcripts with ongoing team review. In this way, the diagnostic use of IRR served as a tool for enhancing reflexive engagement and the interpretive quality of our latent theme development, rather than a measure of coding reliability.

Researchers' Positionality: Braun and Clarke emphasize the importance of articulating theoretical positioning when conducting inductive (reflexive) thematic analysis [12–14]. Reflexivity helps situate the researcher within the research process and clarifies their interpretive standpoint for participants and readers [21, p. 4]. Our analysis was shaped by the backgrounds of the three researchers in Human-Centered Computing education (primary analyst), data science and software engineering respectively which informed our interpretive lens and coding decisions. Our study used Braun and Clarke's reflexive thematic analysis [13], led by the primary analyst and the other two researchers contributed as interpretive collaborators, offering disciplinary perspectives that enriched understanding of teachers' perspectives (e.g. usability, pattern recognition, and technical feasibility). Each researcher in our team brought several years of teaching and research experience in HCC courses (such as User-Centered Design (UCD), Human-Computer Interaction (HCI), Advanced HCI, Human-Centered Software Engineering) and educational technologies, which informed our interpretive lens. In particular, the primary analyst has been teaching several HCC courses including UCD, HCI and Usability Evaluation for fifteen years which provided additional insider insight into HCC educators' pedagogical practices and the challenges they face when integrating emerging technologies. This background enhanced the primary analyst's capacity for reflexive analysis and supported more nuanced understanding and interpretation of educators' contexts and the interview data. While we were familiar with a range of ed-tech tools, we were relatively new to VR as a research context. This combination of experience and emerging perspective informed our interest in understanding educators' practical considerations when integrating VR into authentic educational settings. We held regular analytic discussions and examined how our professional backgrounds and interpretive assumptions informed coding decisions to support reflexivity.

4 FINDINGS

We use themes and codes, along with a frequency analysis represented by n (number of educators) and illustrative quotes, to present findings. In total, three main themes emerged from the data: 'technology access and provisioning', 'pedagogical considerations' and 'VR design and sourcing considerations' encompassing 7 categories of codes as shown in Figure 3. We refer to the entire sample of our participants as 'educators' unless divergent views were expressed, in which case we discuss teachers and learning designers as separate groups. It is to be noted that frequency counts of educators are included solely as descriptive counts for transparency, providing additional contextual insight into how many educators mentioned particular considerations and complementing the rich, qualitative descriptions. Additionally, the counts serve as a form of *'credentialing counting'* [49] enhancing data transparency by providing evidence for the interpretations. Importantly, these counts do not determine the significance of themes which were guided by depth, meaning, and relevance to the research aims in line with reflexive thematic analysis principles.

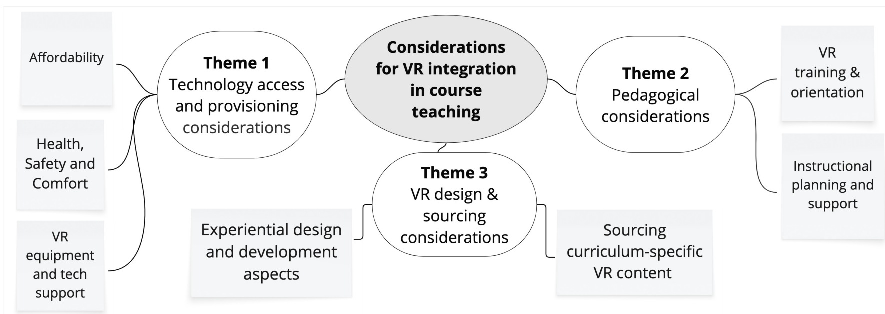

Fig. 3. Considerations for VR integration: summary of themes and categories

4.1 Technology Access and Provisioning Considerations

This theme describes the considerations (summary list provided in Table 1) related to a) VR equipment and tech support, b) health, safety and comfort issues, and c) affordability aspects related to VR technology access and provisioning (illustrated in Figure 4).

Table 1. Considerations for VR Integration: ***Technology access and provisioning***

C	Consideration (C) description	Section
C1	Adequate number of VR equipment	4.1.1
C2	Adequate technology support to set-up, troubleshoot & maintain VR equipment	4.1.1
C3	Adequate technical & administrative support to facilitate student use of VR equipment	4.1.1
C4	Adequate funding for provisioning and administration of VR equipment	4.1.2
C5	Adequate resources & support funding for staff training of VR equipment	4.1.2
C6	Adequate institutional infrastructure & support for use of VR equipment	4.1.1, 4.1.2
C7	Account for the health needs of students relating to the use of VR equipment	4.1.3
C8	Account for safety needs of students relating to the use of VR equipment	4.1.3
C9	Account for classroom layout & context for safe and responsible VR use	4.1.3
C10	Account for comfort needs of students relating to VR use	4.1.3
C11	Account for health, safety & comfort needs of teaching team relating to VR use	4.1.3

4.1.1 VR equipment and technical support. Most educators (n=13) discussed potential **equipment constraints** for VR-supported activity. For example, P5 asked rhetorically, *"...and we do need a lot of these, right?"* and P6 asked, *"...we know the number of students we have, and we wouldn't have 200 of these [VR headsets] lying around."*. Six educators raised issues related to **setting up and technical issues**. They wondered about the appropriate level of support for teachers. P11 explained the issue as following: *"If there are technical glitches, who is going to manage that? Is it the teacher? So I think there has to be someone around that needs to be a backup? What if it's not working?...that sort of knowledge and training is important"*. P6 and P10 brought attention to the **need for student**

support with VR set-up and troubleshooting, as evident in their following quotes: *"if you're going to be working with students that this might be their first time and some might have issues with setup"* [P6] and *"diagnosing issues that students run into is where we [educators] really tend to struggle with it [VR equipment] a bit"* [P10].

4.1.2 Affordability. All fifteen educators raised the issue of **technology cost** as a potential prohibitive factor for more extensive VR use. A quote from a learning designer is as follows: *"you have to have an awful lot of money if you want to have you want every single member of your team to have a virtual headset and interact that way"* [P7]. Other financial constraints due to **institutional budget cuts and payment costs** for teacher preparation came up, such as in the following: *"you know, the budget cuts this semester...TAs [Teaching Associates] don't have a lot of time. They're like associated hours, like prep [preparation] is already cut. So if you're adding more things to them, that would be a further burden, I guess, because they have limited time."* [P9] Furthermore, P9 added that, *"resources like time and money to get the VR headsets enough for like a class and then to like, I like the time and funding to pay TAs to prep for this implementation"*.

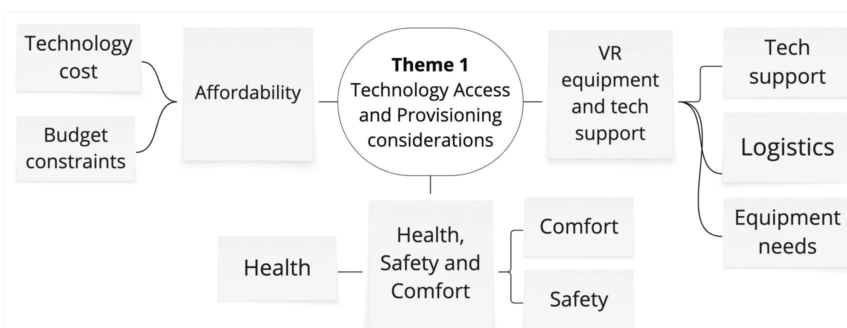

Fig. 4. Technology access and provisioning, its categories and codes: Theme 1

4.1.3 Health, safety and comfort. Health, safety and comfort considerations were discussed at length by all educators (n=15). **Potential health issues** raised included motion sickness (n =8), headache (n=1), vertigo issues (n=1) and epilepsy, seizures or vision impairments (n = 4). Some supporting quotes that describe educators' concerns are as follows: *"...when you're in a virtual space, if you're not kind of moving at the right speed or in the right way you can get kind of seasick..."* [P7], *"People who have got issues with motion and things like that, often they don't feel very comfortable using VR sets and that might be something to consider."* [P5] and *"...There will be some students that [can't use it] for physical reasons - glasses, [or] they might not have eyesight in one of their eyes..."* [P12]. Two educators [P9, P13] also raised the issue of the **hygiene of swapping headsets** between different people: *"Maybe some people just don't want to use a communal headset"* [P9].

Regarding **safety**, P10 raised space considerations in the classroom to run VR experiences and P13 anticipated safety issues : *"I don't want to think 24 people wandering around class with a headset on, you know, potentially throwing up or running into people!"* [P13]. P7 and P15 spoke of the **noise levels of classrooms** and its impact on VR use: *"...if there is a very noisy class, and you are showing virtual reality and telling them like you need to listen, maybe it will not work"* [P15].

All three learning designers and nine teachers discussed potential VR headset related **comfort issues** due to the "size of the object side of the setup" [P14] and how they might be perceived wearing the headset - *"there's always a certain social pressure, people just don't want to look stupid"*, P12 remarked. P9 and P14 also discussed other potential causes for student discomfort such as students' *"comfort to use in a classroom setting in front of their peers"* [P9] and *"preference of non-technical things than...new technology"* [P14].

Ten educators considered the **emotional impact of the VR content** on students that might play into students' feelings of comfort with the VR experience. P9 explained it as follows: *"if the content is somewhat, like it could provoke emotions, maybe people have relatives or friends that are experiencing these conditions that you're stimulating and it's kind of somewhat sensitive content"*[P9]. For such situations, educators suggested access to counsellors [P13], and checking the emotional levels of students before trying the headset [P13, P15]. For example, P15 wondered, *"teachers need to assess mental health of the students...maybe there is some self-reporting tool?"*.

Three educators [P8, P9, P14] felt the **lack of agency** due to getting carried through the VR experience. The following quote from P7 encapsulates these concerns well: *"...you basically feel like you're kind of almost like you might be trapped in someone else. So you can't exert control on your surroundings. So that might be uncomfortable for some people."*.P10 pointed out that it was important to be mindful of **teachers' emotional safety** also and that if the VR experience was "too close to home", "they may not feel comfortable teaching it from that perspective".

4.2 Pedagogical Considerations

This theme describes the pedagogical considerations (summarized in Table 2) related to a) VR training and orientation (for students & staff) and b) instructional planning and support (Figure 5).

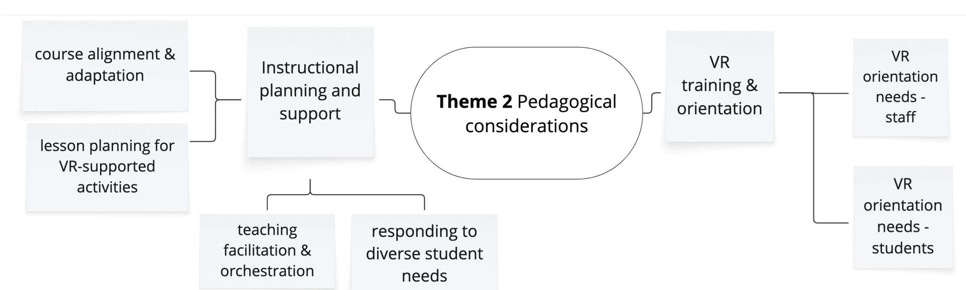

Fig. 5. Pedagogical considerations, its categories and codes: Theme 2

Table 2. Considerations for VR Integration: ***Pedagogical considerations***

C	Consideration (C) description	Section
C12	Account for VR training and orientation needs of students for VR use	4.2.1
C13	Account for VR training and orientation needs of teaching team for VR use	4.2.1
C14	Account for attitudes & perceptions of the unit team towards VR use	4.2.1
C15	Account for curriculum alignment and adaption required for VR-based learning activity	4.2.2
C16	Account for students' learning needs in the instructional planning of VR-based activity	4.2.2
C17	Account for lesson planning for VR-based learning activity	4.2.2
C18	Account for class facilitation & orchestration required to run VR-based learning activity	4.2.2

4.2.1 VR training and orientation. Regarding VR orientation for students, majority of the educators (n=10) were **in favour of VR orientation sessions** for students. P13 reasoned it was important for students *"to get the sillies out of the way"* and so that they did not get *"caught in the novelty"* of it.

Some **training ideas** were proposed by three educators [P3, P6, P14], for example, P6 suggested, *"creating a simple activity that's all about getting used to the idea of putting on and controlling a*

VR set just to get familiar with the environment they are going to be using". P3 considered setting a forum, *"...maybe having a bit of a forum or a portal to ask students what they think about using VR"* and P14 suggested peer assistance, *"...those students who use or who just did the VR should help other students setting up the VR and teaching that..."*. Five educators [P4, P5, P10, P14, P15] did not think pre-class VR orientation for students was necessary as simulations are "quite intuitive" [P4] and "...from a student's perspective, I don't think they need a lot of preparation, apart from having the context already...", P5 commented.

In terms of VR training for staff, all educators (n = 15) opined that **training would be needed for staff**. P2 explained, *"In terms of teachers, you probably need to make sure that the teacher is familiar with VR and how it works...be able to guide the students specifically about what they're looking for"*. Similarly, P7 said, *"...they will need to use it enough that they can troubleshoot"*. P7 and P13 also raised the consideration about **educators' attitudes** to the VR supported activity, as P7 opined *"...If the teacher acts like it's important, the students are given a vicarious sense of importance of it, if the teacher decides it doesn't matter, then the students aren't going to pay much attention to it...at the very least making sure that you have the buy in from them gives you the best chance..."*.

Educators talked about orientation as *"an additional responsibility"* [P1], and involving "a lot of preparation". Some ideas were proposed by three educators [P9, P10, P13] on **what the staff training might incorporate**: having access to a "that pamphlet that has that list of support lines and organizations that they can contact", as P9 put it. All three learning designers contended that it was necessary to train and orient both students and staff members before using VR for learning.

4.2.2 Instructional planning and support. Several considerations related to instructional planning and support were discussed by educators:

Course alignment and adaptation: Three educators [P1, P11, P14] spoke of making space in the curriculum. The quote from P11 illustrates these considerations well: *"how do we manage time? How do we incorporate these additional activities? How do we fit them in the curriculum? So that would be one of the biggest questions for the teachers like management of time, as well as pre-planning of the unit?"*. P7 and P15 emphasized **alignment with learning objectives of the unit** was crucial. P15 said,*"need to find out which particular content needs more immersive experience"* to avoid the situation described by P7 : *"I've seen things where they've just decided to use VR, and then figured out what they were going to do with it"*. P2 thought of some existing course content that might need to be adapted for VR integration: "*there would be probably some WCAG [Web Content Accessibility Guidelines] that aren't really going to be relevant to the VR*". P14 added integrating VR would require "*changing the projects also*", and P1 brought attention to assessing learning from VR particularly, *"what we are assessing"* and *"how we are assessing"*.

Five educators [P2, P3, P8, P9, P10] focussed on **evaluating the effectiveness of VR**. For example, P8 asked: *"It's a valuable thing when they start telling you how it's affected them, when they start to describe their experience that's what I would want to see so I think collecting a worksheet or collecting their responses within an activity - that's going to give you the metrics that you want to know to see whether it's successful"*. P2 suggested some ways to evaluate VR-based learning activities as follows: *"...do a survey for the students and ask what if they used it? Like if they find it engaging? Or if not, maybe why didn't they want to use it? And also, I guess you could look at the grades, and compare grades for those who used it and those who didn't, and just see if there was actually a difference?"*. P3 and P10 suggested evaluating for students and teachers if VR "*has been effective for them*".

Lesson planning for VR-supported activities: Nine educators [P4, P6, P7, P8, P9, P10, P11, P12, P15] discussed when to schedule VR activities in their courses: "*Week 3*" [P4], or "*maybe week 4 or 5*" [P8], or *"somewhere in the middle might be a better way to keep them coming to the workshops because towards the middle, I think the numbers start to fall off so maybe bring in something cool* *to make the students come back to"* [P11]. The ***novelty and interest*** sparked by VR-experience played into some of these decisions, as remarked by P9: *"I feel like if you immerse them in the user experience a bit more, it will hopefully spark a bit more interest, a bit more motivation so maybe there's a point. That's why I think either another VR experience halfway or towards the end would be useful"*.

Other lesson-planning considerations were number of VR scenarios to be used and the length of the experiences [all educators], how to sequence these with other lesson activities [P5, P8] and learning configuration (individual/group) [P8, P10, P12]. For example, P2 suggested using *"two or three scenarios"* and P6 recommended having *" a few of those different contexts"* as *"it wouldn't necessarily be students getting too hyper focused on one particular scenario, and given the flexibility to actually consider a different scenario and how they would approach that and how they provide support instead of just basically trying to solve one specific scenario"* [P10]. For the length, P6 said, "P6 *"three to five minutes wouldn't be too long if there are good elements laid out but if it's repeating the same thing over and over again, it might sound repetitive or boring..."*.

Educators [P3, P5, P10, P15] discussed how **VR experiences could complement other learning activities**. Regarding students not taking up VR experience, P9 expressed, *"I think it would be a disadvantage... what you know being immersed in it, and then just reading about something, it's a bit different."*. Regarding **activity design**, P8, P13, P15 emphasized the importance of having **reflection tasks**, as P13 put it: *"...briefing period afterwards where they reflect on the information that they've got and how they got it. And maybe the teacher can have a look at what they have collected, and maybe start asking them if there are any major gaps in what they seem to have picked up."*.

Teaching facilitation & orchestration: P3 and P10 mentioned the **educators role in briefing and guiding discussions**, with P10 elaborating: *"making sure that the discussions actually occur. So this approach does work, depending on how we frame it in the class and how we write it up that could actually change the outcome or whether it's successfully picked up and engaged with by the students"* [P10]. Educators mentioned orchestration tasks i.e. managing the many class activities (individual, group and class-wide activities) such as checking for participation in the VR activities [P4], troubleshooting VR equipment for students [P7], monitoring VR use and providing emotional support to students if required [P9] and managing a noisy classroom [P15].

Responding to diverse student needs: Educators [P1, P2, P4, P6, P10, P11, P14] discussed students may have different **prior VR exposure** and experiences that might influence how they engage with VR and pedagogical decisions. For example, P14 said,*"...taking up the VR is much easier - it's like anything new. It just is a matter of curiosity and especially considering the age of students, so they are more biased towards new technology."*. However, P2 highlighted the **potential of distraction** for students, *"I suppose that for if they've never used it before, they might be focusing more on the experience of using VR than work on the actual content so that could be another issue. I guess maybe even some new VR users might get distracted"*. To similar end, P12 commented,*"...[VR] technology itself has to be not a barrier or something that the students focus on."*.

Educator P12 discussed potential exclusion of students with **accessibility needs**, *"...if you have any students who have visual impairments, or seizures or motion sickness, or says I wouldn't be able to use the headset so that will be one thing that may exclude some people."*. For such instances, educators [P2, P4, P5, P6, P7, P8, P10, P11, P14, P15] considered alternatives such as *"[VR] video like this in 2D screen as a substitute"*, however, acknowledging that organizing alternatives "*create so much extra work, and I don't think it's realistic"* and *"online class would be difficult because you have to send equipment or make equipment available to students, which is very difficult"* [P4].

4.3 Design and Sourcing Considerations for VR Experiences

This theme (illustrated in Figure 6) describes the design and sourcing considerations for VR experiences related to: a) sourcing curriculum-specific VR content and b) experiential design and development aspects for VR content (see Table 3 for a summary list).

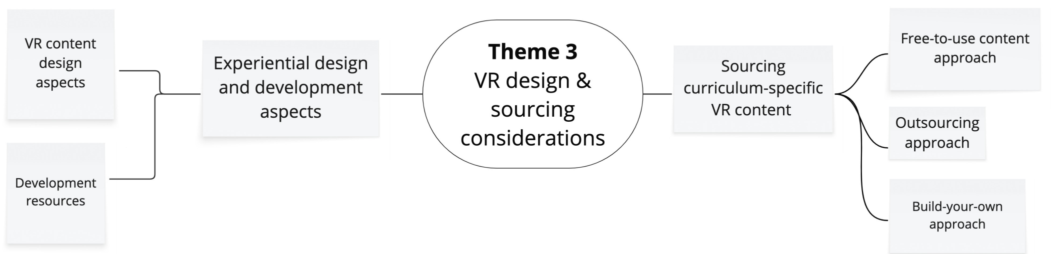

Fig. 6. VR design and sourcing considerations, its categories and codes: Theme 3

Table 3. Considerations for VR Integration: ***VR design and sourcing considerations***

C	Consideration (C) description	Section
C19	Examine resources and constraints for development and/or design of VR content	4.3.2
C20	Determine appropriate sourcing approach(es) for relevant VR content (build-your-own, outsourcing or free-to-use VR content)	4.3.1
C21	Account for relevant experiential design aspects for pedagogical use of VR content	4.3.2

4.3.1 Sourcing curriculum-specific VR content. This emerged as a major consideration for educators, summed up by P8's question,*"Can we have a steady flow of this [VR] sort of stuff?"*. Educators' approaches could be categorised into the following three types, with their pros and cons:

(a) Build-your-own VR content approach: Eight educators [P1, P4, P5, P6, P11, P12, P13, P14] considered the **teachers-as-creators approach**. P12 described it as: *"I know somebody...who actually has 3D camera, and I'd say, okay dude, can you come and help me out, we're gonna do some filming, and we'll work out how...we'll get people to do some acting, substituting, we'll get some funding...we'll set up a shoot exactly like we would do a film shoot but do it in 3D."*.

Educators discussed **production challenges** with this approach as follows: P1 referred to the **data collection needed** to enact these videos as a *"big constraint"* and *"big expectation"* and P5 called VR content creation a *"a burden for the teacher to actually develop that"*. P4 mentioned lack of time and P11 was concerned, *"We are already overworked...in terms of time commitment, there could be a lot of time commitment, as well as investment of resources."*. P12 suggested: *"If there was a community consumer app I could develop easily with, I would build with it... teachers themselves tend to be very isolated, with very little support so that's why they need something that they can just do themselves"*, and added that: *"Teachers are using AI within the design of the VR experience...large language models certainly lend itself to these VR environments."*.

(b) Outsourcing approach: Nine educators [P1, P4, P5, P6, P8, P9, P10, P12, P15] considered **options to outsource VR content** production. As the following quote from P6 illustrates: *"either you find a company or an IT group that designs that for you...have an in-house faculty or within a university that develops this sort of thing, like learning transformation units, that you can go to and say, Hey, here's my case study. Here's my idea"*. P6 also suggested using **VR vendors** - *"other vendors providing videos, they've approached me [online] as a teacher."*. P8 said, *"when the technology in the classroom is*

more readily available, more organizations are going to put this material out...they're already starting to make this sort of stuff that you can buy and download and use and that sort of stuff.". P4 said, *"it [VR development] would end up on* ***another student or an RA [Research Assistant]*** *to do that or a PhD student who researches this topic"*. P10 suggested,*"working in tandem with a* ***research department or a research group****, working with people from that community."*. Regarding co-design option, P15 emphasized, *"it should be a well researched* ***co-design*** *but with the participants and experts."*. P10 added, *"any sort of information here needs to come from lived experiences, it can't just be made up by people that don't have those lived experiences..."* and P14 also emphasized vetting the content with people from represented communities to ensure accuracy of representation.

(c) Free-to-use VR content approach: Educators [P1, P4, P5, P8, P9, P14] also explored the **option of using existing or available free-to-use content**, as P9 summed it as, *"focus on things that are already out there"*. P14 suggested platforms like Youtube: *"as a teacher, I would not actually prepare this content. So I would think that there are already existing videos on the internet from YouTube, my primary source and then maybe I can tweak two minutes or three minutes from some of the videos"*. Educators suggested exploring available case-specific VR material [P4] or asking students to help find some for a given problem statement. There were **concerns regarding the open source content** approach. For example, P1 explained: *"not many videos are made in VR format"* and finding videos *"...would definitely be the biggest task for niche categories."*.

4.3.2 Experiential design and development aspects. Regarding the **experiential design aspects:**, educator P11 mentioned **realism**, *"the scenarios should be realistic, they should be able to tap into whatever the challenges are...those physiological markers, you can have - the voice...the heart beating, the blurriness of the vision - I think these are all very important aspects."*. P1 emphasized realistic **interactions** and P3 added realistic **pacing** i.e. "pace of the video should not be very fast" to prevent motion sickness. Related to **sound**, P7 commented, *"you could hear like the thought process of the person and you could hear moving around...hear like footsteps...that aspect is important"*. P8 and P15 highlighted the importance of **local context and culture** to make it more localized and relevant for students, as P15 said, *"cultural consideration is very, very important...language they use... all kinds of religious restrictions could also be there."*. Furthermore, the issue of **character representation** was brought up by educator P11 who discussed how the cartoon characters can feel "little bit clunky...and you wouldn't feel the human component", and P7 commented: *"Look, you can't design these trophy, one dimensional characters, there has to be some depth to it, someone can't just exist and you can kill them off - they're nothing but a bunch of* ***stereotypes****, right?"*.

Regarding **development aspects**, eight educators [P1, P4, P5, P6, P10, P11, P12, P14] discussed VR development resources, captured by P5 as *"even if it [VR] is a few minutes, the teacher would probably need a lot of resources to do it"*. For resources, P1 listed, *"Access to the technology to shoot the video itself...and we have to learn that and then we have to learn editing..."*. P4 suspected that developing 3D scenarios might require *"quite powerful computers"* and P1 pointed out developing interactive VR content would further drive up development costs and add to the training requirements.

Other considerations discussed were **ethics** (*"proper ethics and all the approvals"* [P12]), **bureaucracy** (*"including real users might be more time consuming and difficult and requires ethics approval, and I might be too deep in the university bureaucracy"* [P4]), and **workload and incentives** (*"...increasing the workload...additional incentive...most innovative approach of teaching...those kinds of incentives might motivate teachers playing with fear."* [P14]).

5 DISCUSSION AND IMPLICATIONS

5.1 Research Findings

We discuss our findings corresponding to the three interview themes as follows:

5.1.1 Technology access and provisioning considerations: Our analysis revealed several important considerations regarding **VR equipment and technical support provisioning** (Table 1), particularly the need to determine an appropriate number of headsets and to establish adequate technological and administrative support for setup, troubleshooting, and maintenance. These findings highlight the need for **strategic planning and institutional coordination** in technology integration efforts. Prior research identified challenges in **operating and maintaining** VR systems and stressed the importance of staff training, technical skills, and leadership support through policy, funding, and vision [25, 69]. However, the literature offered limited insight into how institutional support structures specifically enable or hinder VR integration in HCC classrooms, where educators often require flexibility to trial and iterate human-centered experiences. **Affordability** was a unanimous concern among educators, consistent with widespread findings that high costs for hardware, software, and scenario development limit VR scalability and adoption [58, 62, 68]. Beyond procurement, educators raised concerns about **limited institutional funding, budget constraints, and the lack of compensation for teaching assistants** involved in VR-specific tasks, all of which compound the resource-intensive nature of VR integration in HCC curricula.

Health-related needs were also prominent, particularly regarding cybersickness, headaches, and accessibility challenges for students with epilepsy. These issues are supported by existing research on visual discomfort and the prevalence of cybersickness in immersive environments [29, 40, 80]. However, literature remains underdeveloped in addressing the **accessibility** of VR for students with epilepsy, neurodivergence or cognitive differences - groups for whom VR may pose unique usability and safety challenges [26]. **Safety concerns** included risks of physical collisions due to confined classroom spaces or high ambient noise during immersive sessions. These highlight the need for deliberate classroom planning, especially in shared HCC labs or studios. Educators also noted **comfort issues**, including a perceived loss of agency and potential emotional distress triggered by realistic simulations. Educators noted that they too may face physical or emotional effects, yet little research addresses **educators' health and safety** in VR teaching contexts.

5.1.2 Pedagogical considerations: Educators were divided on the need for a formal **VR orientation for students** (Table 2). Some viewed it as essential, while others felt VR's intuitiveness made it unnecessary. Prior studies show that students' initial VR experiences can influence their engagement, and that novelty alone does not ensure learning [55]. All educators (n = 15) agreed on the importance of comprehensive **VR training for staff**, aligning with research that highlights gaps in both technical proficiency and pedagogical preparedness among educators in VR-supported HCC education [37, 52]. Educators also stressed the need for intentional **instructional design** (Table 2), reinforcing evidence that VR's value lies in its integration into purposefully designed learning experiences [66]. This includes alignment with learning objectives, assessment strategies, and curriculum goals [37]. The need for active **facilitation and supervision** was another recurring theme. Educators expressed challenges echoed in literature [30] about student disengagement or overwhelm in immersive environments especially in classrooms adopting student-centered pedagogies. Effective integration also involves real-time monitoring of students' **cognitive and emotional engagement**, supported with learning analytics and interaction trace analysis [66].

5.1.3 VR Design and sourcing considerations: Educators identified several key issues related to **sourcing and developing curriculum-aligned VR content** (Table 3). While some considered a **build-your-own** approach, most viewed it as resource-intensive, requiring advanced technical skills, interdisciplinary collaboration, and navigation of institutional bureaucracy. This aligns with Riches et al. [62], who noted that bespoke VR training demands partnerships with cognitive science and technology experts to ensure domain relevance. A preference for **outsourcing or using pre-existing VR content** emerged, aligning with HCC principles that promote collaboration with educators and subject experts to enhance empathy and contextual relevance [36]. However, educators noted that **pre-made VR resources** often lack personalization and contextual fit. This echoes findings by Marougkas et al. [43], who identified the need for features like real-time interaction, personalized feedback, and intuitive navigation - core to HCC's emphasis on usability,

Design considerations specific to HCC education also surfaced, including the importance of **immersion quality, cultural relevance, and character representation**. These highlight the need for inclusive, context-sensitive design - an area still underexplored in current VR research [11, 22]. Educators emphasized the value of realistic pacing, audio synchronization, and narrative engagement, consistent with attention design strategies in immersive learning [9]. Reflecting HCC's participatory ethos, several educators advocated for **co-design with students, community members or content experts** aligning with literature that supports collaborative VR design in education [53]. Yet, concerns around **workload, training, and ethics approvals** persist, reinforcing the institutional barriers to VR integration. As Jensen and Konradsen [29] caution, poorly designed VR can be counterproductive causing cybersickness or distracting from learning goals, highlighting the importance of intentional, well-supported design & implementation.

5.2 Implications for Teaching in HCC Education

We present teaching implications of the three interview themes below & summarized in Table 4:

5.2.1 Technology access and provisioning implications in HCC education: VR access in HCC education is likely to be constrained by limited headset availability, requiring students to **share or rotate equipment**. Affordability challenges may hinder scalability, particularly in under-resourced settings [4] where educators must **balance pedagogical aspirations with budget constraints**. Technical issues, setup complexity, and limited support services, as noted by educators and in prior research [10], imply a need for **institutional support and troubleshooting assistance** [52]. Health-related concerns [40] highlight that **not all students may be able to safely or comfortably engage with VR**, requiring careful planning around session duration, opt-in participation, and inclusive alternatives [43]. Safety and classroom management must also be considered [46], especially in group or shared environments. To support student wellbeing, educators may need to **monitor discomfort and refer to support services** if needed [73].

Table 4. Implications for teaching in HCC education

Considerations	Implications for teaching based on these considerations
Technology access and provisioning implications (Section 5.2.1)	Using VR headsets according to headset to student ratio constraints Balancing pedagogical VR aspirations against teaching budgets affecting scalability Organizing technical assistance and available institutional support for VR sourcing & troubleshooting Considering health needs for students who may not be able to participate in VR activities Managing classroom and facilitation for safe VR use Monitoring student well-being throughout VR use and offer support as necessary
Pedagogical implications (Section 5.2.2)	Organizing targeted professional development for educators for VR use Implementing structured VR orientation sessions for students Designing VR activities that are scaffolded and aligned with course learning outcomes Planning VR-based learning activities carefully aligned with pedagogical needs Designing VR activities to support inclusive students needs
VR design and sourcing implications (Section 5.2.3)	Collaborating early on with learning designers and institutional support units for VR design & use Weighing resource demands & trade-offs of VR sourcing -building, outsourcing, free-to-use Consider existing open-source or free-to-use VR materials for low barrier to entry Piloting small-scale, proof-of-concept VR experiences and activities for low-risk implementation Being intentional about context-specific VR content selection Piloting VR scenarios with relevant stakeholders for accuracy, pedagogical value & emotional impact

5.2.2 Pedagogical implications in HCC education: Educators emphasized the importance of **targeted professional development** to build both technical proficiency and pedagogical strategies for VR use [6]. This includes structured **VR orientation sessions for students** and the design of **scaffolded activities aligned with course outcomes**. Effective lesson planning requires thoughtful integration of VR, including **activity length, repetition, scheduling, opt-in vs mandatory participation, and post-activity debriefs** [18, 79]. Pedagogical approaches must also prioritize **inclusive design** [9, 15], offering alternative access modes (e.g., desktop-based simulations) for students with specific physical, emotional, or accessibility needs [26].

5.2.3 VR design and sourcing implications in HCC education: Our findings suggest that **educators should collaborate early with learning designers and institutional support units** [69] to navigate the resource demands and trade-offs of sourcing approaches (building, outsourcing, or using free-to-access VR content) to ensure realistic workload expectations and pedagogical alignment [58]. HCC educators new to VR may consider **existing open-source or free VR materials** [59], or pilot small-scale, proof-of-concept VR experiences [19] and activities to allow for low-risk experimentation without over-committing resources. Our considerations for experiential design aspects and related studies [22, 53] imply **intentional VR content selection** is important for HCC educators. This includes realistic scenarios, cultural and contextual relevance [60] and involving people with lived experience, practitioners, or community members when using VR for sensitive or experiential topics [1]. Piloting content with students and collaborators can help validate its **accuracy, educational value, and emotional resonance**.

5.3 Implications for Research in HCC Education

Based on our interview findings, we propose the following seven key implications for research in HCC education:

1. **Exploring pedagogical facilitation strategies and educator training influence:** Based on the pedagogical considerations (Sections 2, 5.1.2), future research could investigate facilitation strategies for VR-supported learning in HCC education. This may include how VR can support HCC student projects, ethical reflection, and design activities, as well as how educator training interventions impact instructional design practices in these contexts.
2. **Implementation in authentic classroom contexts:** Research should examine how real-world HCC classroom conditions affect the adoption and effectiveness of VR-based activities. This includes validating the considerations identified in our study (Tables 1, 2, 3) and identifying new challenges during in-situ application.
3. **Engage educators in ongoing, practice-based collaboration:** Collaborating with educators implementing VR in HCC can reveal practical challenges and discipline-specific needs, informing both curriculum and professional development.
4. **Designing VR experiences for learner diversity:** Given the emphasis on inclusivity in HCC education, future work should examine how experiential design elements such as realism and interactivity can be adapted to support diverse learners with disabilities or limited technical experience (Sections 2, 5.1.2) while aligning with HCC learning outcomes.
5. **Developing sourcing and decision-making frameworks:** Research should focus on creating decision-making frameworks to support educators in selecting, adapting & developing VR content. These frameworks should ensure pedagogical alignment with course goals (e.g. ethics, social impact) along with technical and resource constraints (Sections 3, 5.1.3).
6. **Examining institutional support for sustainable VR integration:** Based on technological access and provisioning considerations (Section 1, 5.1.1), we recommend examining how

institutional factors such as institutional VR infrastructure, tech support, equity, and faculty incentives would affect VR integration in HCC education and its sustainability.

(7) **Investigating disciplinary-specific VR integration needs:** While this study focused on HCC, future research can benefit from conducting comparative studies in disciplines such as health sciences or business management. This can help identify shared and unique VR integration challenges, informing broader pedagogical and institutional strategies.

HCC-specific VR integration considerations: While our findings reaffirm several barriers to VR adoption in education such as cost, equipment limitations, and cybersickness, this study also highlights distinct challenges and opportunities specific to HCC education. In particular, our findings foreground the following interrelated considerations that map directly to the teaching and research implications outlined in Sections 5.2 and 5.3.

(1) **Co-designing VR experiences with stakeholders**, which aligns with prior literature emphasizing participatory design and authentic user engagement in computing education [51, 64]. In practice, co-design could involve educators and students in scenario creation, testing, and feedback cycles, ensuring immersive activities reflect real-world contexts and pedagogical goals, as outlined in *Teaching Implications 1-3 under VR design and sourcing*, and *Research Implication 3*. These connections reinforce the value of HCC participatory design practices when creating VR content for educational use.
(2) **Ensuring cultural relevance in immersive content**, supporting diverse student and user perspectives, as highlighted in literature for accessible and context-sensitive computing education [20, 71]. This could be practically addressed by adapting VR content for different student backgrounds and abilities, providing alternative modes of interaction, and consulting diverse user groups during design. This corresponds to implications around intentional content selection and inclusive pedagogical design such as *Teaching Implications 4-5 under VR design and sourcing, Teaching Implications 4-5 under Pedagogical and Research Implication 4.*
(3) **Supporting emotional safety**, which can be important in VR contexts where immersive experiences may evoke affective responses [42, 72]. Supporting emotional safety maps closely onto pedagogical implications related to structured orientation sessions, careful planning of activity length and debriefs, and inclusive participation strategies *(Teaching Implications 1–4 under Pedagogical; Research Implication 1)*. Emotional safety also ties to technology-related considerations such as monitoring student discomfort, managing health constraints, and offering opt-in participation *(Teaching Implications 3-6 under Technology Access and Provisioning; Research Implication 2).*
(4) **Managing orchestration in studio-style classrooms**, which requires attention to spatial, temporal, and technical constraints [59, 62]. This aligns with implications related to equipment-sharing arrangements, workflow planning, troubleshooting support, and classroom facilitation *(Teaching Implications 1-3 and 5-6 under Technology Access and Provisioning and Research Implication 2).*

These considerations reflect HCC's unique pedagogical values and design practices, extending beyond common logistical concerns to advance more context-sensitive, participatory, and inclusive approaches to VR integration in computing education, ultimately enriching how computing students learn to understand and design for diverse technology users. They also link to HCC teaching and research implications outlined in Section 5.2 and Section 5.3 for supporting educators in integrating VR effectively in authentic classroom contexts.

5.4 Limitations and Future work

Firstly, the sample size of 15 educators limits the generalizability of our findings, this was not the study's primary aim. Instead, we sought to deepen understanding of computing educators' perspectives on pedagogical considerations, issues, and challenges in integrating VR into teaching. The resulting 21 practical considerations, though not exhaustive, offer useful guidance for educators and administrators planning VR adoption.

The second limitation is that all fifteen educators were affiliated with higher education institutions in Australia. This geographic co-location may reflect shared professional norms, which could limit the transferability of findings to other contexts. Nevertheless, this focus offers a contextually rich understanding of educators' perspectives within a specific national and disciplinary setting. Furthermore, the diversity of participants across domains (e.g., games development, web design), roles (teaching, learning design), and experience levels (1-10+ years) enhanced the richness of the data. Future research could broaden the sample to include educators from a wider range of geographic contexts and disciplines to explore the transferability and variability of the findings.

Consistency in data collection and analysis supports the credibility of our findings. We conducted each study session individually with each educator, and we did not share details about their involvement or responses between participants. This study design helped ensure that responses were independently formed and not influenced by bias or groupthink.

The third limitation is that this qualitative study did not examine correlations between demographic factors (e.g., experience level, gender) and educators' views on VR integration which would be an avenue for future research. Similarly, studies involving participants with varied levels of familiarity and attitudes towards VR may yield further insights and enhance the transferability of findings. While not universally generalizable, our findings may be relevant in other educational contexts. We encourage researchers to test their applicability across disciplines. Furthermore, acknowledging the ethical considerations of VR integration, we stress the importance of aligning VR use with curriculum goals, ensuring it complements rather than replaces socially collaborative learning in HCC education.

6 CONCLUDING REMARKS

This study underscores the importance of intentional, context-aware integration of VR in computing education, highlighting 21 key considerations across technology access, pedagogy, and design. Educators need to consider technical and institutional barriers, prioritize student well-being, and adopt curriculum-aligned VR integration approaches. The practical implications for teaching and research from our study offer a foundation for informed decision-making and design of pedagogically-suitable VR experiences, guiding educators, administrators, and researchers toward sustainable and impactful VR-based learning in real-world classrooms.

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A INTERVIEW QUESTIONS

We asked the educators - *"What practical considerations would be important to you in integrating VR into your course teaching?"*. We kept the main question open-ended and broad to keep it open to all educator ideas and aspects related to VR integration. We adapted the following questions to prompt educators to explain, elaborate, and delve deeper into key issues:

- *How would this consideration impact your VR course teaching?*
- *What issues (if any) do you anticipate in your course teaching due to this consideration?*
- *How do you anticipate overcoming the issues caused by this VR consideration in your teaching?*
- *What challenges or concerns (if any) do you anticipate for yourself or your teaching team when integrating VR in your course delivery?*
- *What equity-related considerations might be relevant to your course related to equity related to the use of VR simulations in your course teaching?*
- *What equity-related considerations might be relevant to your course when using VR simulations, particularly in relation to student access, inclusion and diverse learning needs?*
- *What type of challenges or issues (if any) do you anticipate for teachers in adapting to the use of VR in teaching?*
- *What type of challenges or issues (if any) do you anticipate for students in adapting to the use of VR in teaching?*
- *What type of training or support (if any) would you or your teaching staff members require to comfortably integrate VR in your teaching?*

To conclude the interview, we asked: *Is there anything else you would like to add in relation to VR integration?* to encourage educators to reflect on any aspect that may not have had the opportunity to cover or elaborate on earlier and share additional insights or thoughts.

B PARTICIPANT DEMOGRAPHICS AND PREVIOUS VR USE INFORMATION

The following table contains the participant demographics and VR use information. Please note we are not disclosing the gender identity of individual participants as one participant in our study identified as non-binary and revealing which participant this was could potentially compromise their anonymity. We are committed to inclusive and respectful representation of all identities while safeguarding the privacy of those who contribute to our work.

Participant	Age range (years)	Role	Experience (years)	Previous VR use	Previous VR use in teaching	Open to using VR in teaching
P1	25-34	Teacher	2-4	Yes	No	Yes
P2	35-44	Teacher	10+	Yes	No	No
P3	25-34	Teacher	1-2	Yes	No	Yes
P4	35-44	Teacher	1-2	Yes	No	Yes
P5	35-44	Teacher	7-10	No	No	Yes
P6	35-44	Teacher	10+	Yes	No	Yes
P7	25-34	Learning Designer	7-10	Yes	No	Yes
P8	35-44	Learning Designer	10+	Yes	Yes	Yes
P9	25-34	Teacher	2-4	Yes	No	Yes
P10	25-34	Teacher	7-10	Yes	No	Yes
P11	35-44	Teacher	2-4	Yes	No	Yes
P12	45-54	Learning Designer	10+	Yes	Yes	Yes
P13	55-64	Teacher	10+	No	No	No
P14	25-34	Teacher	1-2	No	No	Yes
P15	25-34	Teacher	1-2	Yes	No	Yes