Hybrid Model for Tutorial Engagement

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Abstract

Technology has increasingly become a key component of teaching and learning, particularly with the rapid shift to delivery through online platforms as a result of the ongoing COVID-19 pandemic. In 2020–2022, students who studied online often struggled to achieve key learning outcomes and receive lower marks than their on-campus peers, demonstrating reduced engagement in an online environment. A shared concern identified within the School of Architecture, Design, and Planning at the University of Sydney, was the ability to deliver a sense of physical experience to students who are studying online. This paper details our proposed solution to improve engagement in online tutorials through a 'Hybrid Model' that: leverages rapidly advancing virtual reality technology; integrates the fundamental principles of gamification and incorporates experiential learning into the learning process. These three key areas are further supported by a recommended tutorial structure or time proportion model. The manuscript presents the developed theoretical hybrid model informed by existing literature and studies; and illustrates this theory by examples of practical implementation and initial proof-of-concept studies. The manuscript further discusses future research that will focus on in-depth user studies and rigorous evaluation of the approach.

Keywords

online teaching, engagement, virtual reality, gamification, interactive tutorials, experiential learning, higher education.

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1. Introduction

The Covid-19 pandemic has caused global disruption to traditional methods of teaching and learning. At the start of 2020 (after coronavirus disease was first reported on 31st December 2019), many universities launched a sudden adoption of online education. More than 2.5 years on from the declaration of Covid-19 as a pandemic, there is ongoing uncertainty within the global community regarding group gatherings and national and international travel and e-learning remains at the forefront of tertiary education. It is widely acknowledged in the educational community that online or remote teaching has both advantages and disadvantages [Faulconer et al., 2018]. As evidenced by recent studies, remote learning can be more flexible in terms of accessibility and time management [Dallal et al., 2021]; it can also be handy for automating activities or recording data online. However, it is still often inferior to face-to-face teaching, particularly when related to such criteria as active participation, a sense of belonging, and engagement levels which are proven to be strongly correlated with learning outcomes [Walker et al., 2021; Sweetman, 2021].

Throughout 2019–2022 a vast majority of students after each semester consistently echo emerging challenges/barriers associated with online learning [García-Morales et al., 2021]. Within the University of Sydney (USYD) in 2022, many classes continue to be delivered online in order to cater to the varied needs of student cohorts who are not only situated in Sydney but around Australia and the world. It seems likely that in the context of higher education at least some components of online learning and teaching will remain present for a foreseeable future [Ibid.]. That is why it is important to treat the situation as semi-permanent rather than a temporary disruption and address the challenges associated with online teaching more systematically.

Students who study online often struggle to achieve key learning outcomes and receive lower marks than their on-campus peers, which demonstrates the impact of this reduced engagement in an online environment [Curry, 2016]. Beyond the individual, there are wider implications for those students who do participate but may not be able to have engaged and collegial discussions with their peers as the number of students taking part in group discussions is reduced when there is a lack of engagement overall. It was identified that the improvement of engagement from online students is a common issue among multiple cohorts across all university faculties. Symptoms of this lack of engagement in the online tutorials include students choosing to join Zoom classes without video; not participating in break out rooms and/or whole group discussions and instead choosing to stay silent; being more obviously distracted in class and having difficulties with the teacher's ability to check in on individual students to monitor their progress within this online environment. Engagement is an antecedent and facilitator of deep learning; deep learning leads to a more positive and transformative learning experience [Ramsden, 2003].

Several recent studies explored the relationship between online education and levels of student engagement focusing on course design [Tualaulelei et al., 2021], applying self-determination theory [Chiu, 2022], or even using the power of humor [Erdoğdu et al., 2021]. It is evident that digital technology, tools, and platforms have a great capacity to support online learning [García-Morales et al., 2021]. However, there is a clear gap in knowledge in relation to bringing all those components together and applying them in a targeted and holistic way. To address this gap of knowledge the aim of this study was to find hybrid practical solutions to improve engagement and consequently provide a richer and more rewarding learning experience for the online students. It should be acknowledged that there hardly could be a solution that fits all (being discipline and context-specific), and each learning activity must be adjusted to suit its learning and teaching objectives.

This project investigates the challenge of how to improve engagement in online tutorials that have been traditionally taught face to face, with a focus on the field of architecture. Technology has increasingly become a key component of teaching and learning, particularly with the rapid shift to teaching and learning delivery through online platforms [Ibid.]. In the context of architectural education, the challenge is delivering a sense of physical experience to students who are studying online. In the discipline of architecture, students participate in site visits, having the chance to observe forms, spaces, and design features within urban contexts and interact with physical objects. Within an online delivery context, it is not possible to deliver an identical experience; the lack of physical and multi-sensory experiences available to the online learners is especially evident. This project posits that by enhancing the sense of physical experience students encounter in online classes, student engagement with content, learning activities, their peers, and the teacher will improve, leading to an overall boost in the teaching and learning experience of all stakeholders involved.

It was proposed to investigate novel technological advances and to develop a holistic hybrid model that combines a set of methods designed to boost the levels of engagement of students who study online. These opportunities included: 1) leveraging from rapidly advancing virtual reality technology; 2) integrating the fundamental principles of gamification and 3) experiential learning into the learning process; 4) all further supported by dedicating most of the time to practical activities and less time on one way lecture-type delivery (an approach named the time proportion model). This manuscript explains the developed theoretical hybrid model that was informed by existing literature and studies and illustrates this theory through practical implementation examples.

Although this project focuses on architecture delivered at the university level, the responses developed in this study are relevant and applicable to teaching in online environments more broadly, across disciplines and education levels.

2. Context, Literature Review, and Relevant Precedents

2.1. Context

This proposed 'hybrid model' is the culmination of the consideration of a range of diverse teaching and learning contexts, each with its own circumstances, but sharing the issue of improving engagement in online tutorials that have traditionally been taught face to face. The associated teaching and learning contexts vary from one-hour synchronous tutorials of 6–25 students to much larger student cohorts and longer tutorial times. Within the authors' context, the students may be first-year recent high school graduates, or students in the second and third years of their degrees, some of whom are mature-age students retraining in a new discipline. In 2021/2022 approximately half of the Architecture students enrolled to take their studies face-to-face (on-campus), while the other half of the students attend both lectures and practical studio sessions purely online, where the online students are mostly international and based overseas.

The rapid and synchronous shift of many institutions all around the world to virtual classrooms has provided a hothouse for the development of novel approaches to this type of education. It is evident that there are gains in terms of flexibility and access; with the benefit of now more than 12 months of trial and review the limitations in emulating a sense of physicality and creating engagement are apparent. There is ample scope for innovation in this sphere — such as this proposed novel model.

2.2. Literature Review and Relevant Precedents

The literature review has revealed several barriers and opportunities associated with online teaching and learning [Faulconer et al., 2018; Dallal et al., 2021; Tualaulelei et al., 2021]. Findings of the study conducted by Thomas Chiu [2022] suggest that three key aspects have to be considered for creating an engaging online learning environment: 1) provide space where students could socially interact with their teachers and peers to **build a stronger sense of belonging** 2) let students **express their emotions**; and 3) adopting "learning more and evaluating less" assessment approaches. Another suggestion was to **use humor, fun, or entertainment elements** for such purposes/uses as attention, recall, feedback, and humor/fun breaks [Erdoğdu et al., 2021]. García-Morales et al. [2021] reiterate that the challenge for academics working within hybrid teaching and learning environments will be to ensure that both face-to-face and online students experience high-quality learning. According to Ahshan (2021) to increase engagement for online teaching **a structural approach/framework is needed to combine and balance the use of teaching pedagogy, educational technologies, and an e-learning management system**. The authors state that future research could examine an optimal combination of the tools/technologies for active student engagement. This study was informed by existing research and body of knowledge in the field and the future research directions suggested by some of the identified key studies.

Synchronous activities such as video conferencing, opportunities for **questions, polls,** and **real-time demonstrations** have all been identified as methods of enhancing teacher-learner interaction and improving engagement [Walker & Koralesky, 2021]. Interestingly, students have shown a preference for a live chat over on-camera questioning when it comes to posting queries [Lomicky & Hogg, 2012]. The experience of the members of this group has reflected this observation, with students in the authors' classes preferentially using the Zoom chat function rather than audio +/– video to respond to questions or interact in classes.

Peer-to-peer interaction also contributes positively to student engagement. EdTech technologies have expanded opportunities for student engagement and refer to "the design and technological characteristics of the web that feature two-way communication" [Ibid.]. There is evidence that peer interaction and discussion as a technique "supports **thinking and reflection in real-time which promote deeper and more powerful learning**" [Smyth, 2011]. Sweetman [2021] advocates for the use of tools that allow students to text in questions to give a **sense of control over the learning experience**. In their 2021 study, Walker and Koralesky report that students found peer-to-peer interaction helpful in enhancing understanding.

Budhai and Skipworth [2017] suggest **gamification as a method of creating a culture of participation** where learners interact with material as a community and active learning takes place. Sweetman [2021] also suggests that an individual's online attention span is more limited than when content is delivered in person; consideration should be given to teacher instruction composing less than ten minutes at a time, and half of the allocated lesson time. This provides space to consider alternative methods of content delivery — such as gamification. Gamification can contribute to engagement and motivation through the task and goal-based activities with instant rewards — particularly suited to those students **motivated by a sense of fun and performance goals**. In their study, Campillo-Ferrer et al. [2020] suggest gamification encourages critical thinking and innovation. Implemented well, gamification allows knowledge to be applied and experimented with within a risk-free environment [Budhai & Skipwith, 2017].

In our study, we particularly focused on the learning issues that are relevant to education in the field of architecture. In the context of architecture, experiential learning, interacting with materials, and understanding spaces are particularly important. **Physical experiences** provide an opportunity for experiential learning: a means of bridging the gap between theoretical knowledge and its application to real-world scenarios. The aim is to engage the learner with the material in such a way that their interaction with content becomes personalized and meaningful to the individual and their context; the learning journey — including the **reflective and recall components** — will be different for each person [Beard & Wilson, 2018].

In the physical world, interaction with objects and spaces **stimulates a range of senses** that contribute to the learner's understanding and furnish memory with triggers associated with that moment: smell, touch, and sound [Globa et al., 2022]. Some of these aspects of experiential learning are limited in the online environment — however, there are benefits to be gained. The elimination of geographical restrictions and mobility requirements, combined with the capacity of technology to scrutinize objects and spaces in an in-depth and efficient manner can provide a learning opportunity that although different, is not less worthwhile than a traditional physical interaction.

Immersive virtual reality is a potential means of delivering a physical experience online, with users reporting a high level of engagement with the material presented and providing a sense of "being there". It is worth noting though that most reported applications of this technology have been focused on the user experience and learning design rather than considering how to practically integrate this into course curricula or its pedagogical basis [Radianti et al., 2020]. Di Natale et al. [2020] note in their systematic review of immersive virtual reality and higher education note that Virtual Reality (VR) systems offer a strong opportunity to support effective learning experiences, both in terms of effectiveness in knowledge attainment and retention and motivational outcomes. The authors report that **VR activities and experiences motivate students to learn and elicit their interest and engagement with the learning materials**. Among the main of immersive VR environments is the possibility for learners to have first-hand experiences that might not be possible in the real world.

Jonathan Firth [2020] states that it is **possible to boost learning by changing the order and timing of tasks.** The author notes that the application of such techniques as spacing (introducing spaces or delays between activities) and interleaving (mixing of types of learning items — i.e. problems, images, or examples) could be highly beneficial, but their use should be context-specific. teachers will need to build in delays between practice sessions. A study 'AttenQ-Attention Span Detection Tool for Online Learning' by Koshti et al. [2022] revealed that **the attention span of students has gradually reduced due to online learning.** Sweetman [2021] suggests that an individual's online attention span is more limited than when content is delivered in person; consideration should be given to teacher instruction composing **less than ten minutes at a time**, and half of the allocated lesson time.

In summary, the literature reveals that a solution to the problem of delivering experiential learning online is not simply a matter of selecting suitable technology. Attention must be given to the structure of the content, monitoring engagement, establishing interpersonal connections, maximizing student motivation, and designing for learning. Drawing from these findings and insight our study has identified that:

1) a holistic/hybrid approach is needed to fully support online learning and improve engagement levels [Ahshan, 2021; Radianti et al., 2020; Chiu, 2022; García-Morales et al., 2021];
2) strategic use of timing and order of teaching activities can improve learning [Firth, 2020; Sweetman, 2021; Koshti et al., 2022];
3) use of immersive interactive environments such as VR systems and experiential learning can help improve the levels of engagement and delivering a physical experience online [Radianti et al., 2020; Di Natale et al., Colombari & Paolucci, 2021; 2020; Globa et al., 2022];
4) inclusion of fun activities and gamification can improve both engagement and facilitate deeper learning [Campillo-Ferrer et al.; 2020, Budhai & Skipwith, 2017; Sweetman, 2021].

3. Methodology

This study was organized as an exploratory research project. It was set up as a proposition of theoretical framework and initial proof-of-concept studies that investigated a hybrid/holistic way to overcome the fundamental challenges associated with remote teaching and learning practices in architecture. This research method offered a flexible and investigative approach aiming to gain a better understanding of current challenges and opportunities and to improve and inform future research in the field.

The first stage of this project progressed through a rigorous literature review of recent studies and practical applications to improving online teaching and learning that was followed up by proposing a solution, that was based on the key theories and their explanations. The literature review and studies presented in the previous section of this manuscript were selected based on three key parameters: a) they had to be recent (carried out in the past 5 years), and b) they had to involve experimental studies investigating online teaching and learning, and c) they examined levels of engagement.

Based on the findings from literature reviews and identified research gaps and solutions this study proposed a ‘Hybrid Model’ aimed to improve engagement in online tutorials within higher architectural education. The model that is detailed in the next section encompasses four key components: 1) adapting the time proportion model for tutorial structure; 2) using the affordances of immersive virtual reality technology; 3) integrating the fundamental principles of gamification, 4) implementing experiential learning.

4. Proposed 'Hybrid Model' to Improve Engagement

The proposed hybrid solution involves leveraging rapidly advancing virtual reality (VR) technology and integrating the fundamental principles of gamification and physical experiential learning into the teaching process. This is further supported by a recommended tutorial/time proportion model.

Our model draws on the key principles that include transitioning from the lower-level cognitive skills such as 'remembering' and 'understanding', to higher-order thought processing such as 'applying' and 'analyzing' all the way towards 'evaluating' and 'creating' [Brookhart, 2010; Buddha & Skipwith, 2017]. This proposal not only employs activities and applications that can be sequentially implemented to improve students' engagement and achieve deeper learning [Asikainen & Gijbels, 2017] but also includes the time measure as a key aspect in informing tutorial structure and proportioning of activities. It is vital to account for the limited attention span of online learners [Sweetman, 2021] and to balance the time that is being dedicated to different types of activities such as:

1) passive delivery of information via lectures;
2) time spent on the active application of knowledge, practical exercises, or tests; and
3) activities that employ evaluation and reflection working towards the creation of new artifacts [Beard & Wilson, 2018].

Several methods are proposed by which engagement is optimized and the sense of physical experience can be communicated: gamification, experiential learning, and integration of immersive interactive environments such as VR. We utilize a 'learning through experience' process that is immediately followed by reflection on the acquired experience [Kolb & Kolb, 2005]. The experiential learning 'cycle' that iterates between 'abstract observation' > 'active experimentation' > 'concrete experience' and > 'reflective observation', ties nicely with Bloom's Revised Taxonomy [Zapalska et al., 2018], both of which have informed our proposed formula (Figures 1–4).

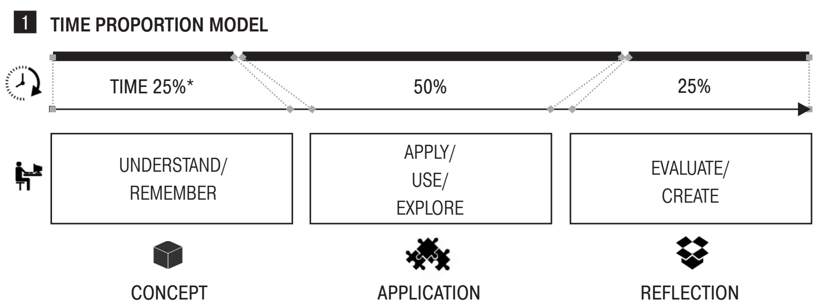
4.1. Time Proportion Model

The proposed time proportion prioritizes active student engagement and practical activities applied within the discipline of architecture and reduces the time-heavy lecture delivery that is traditionally used in higher education settings. As illustrated in Figure 1, we distribute activity time as follows:

- 25% for remembering / understanding activities that refer to the 'Abstract Solution' (no more than 10 minutes [Sweetman, 2021]);
- 50% for active applying / analyzing tasks that refer to the 'Case-based Application';
- 25% for evaluating / peer-review and co-creating activities that refer to 'Reflection'.

The time proportion is informed by both the literature reviews [Firth, 2020; Sweetman, 2021; Koshti et al., 2022]. Lengthy (over 40 minutes) lectures are not as effective in terms of maintaining students' attention at high levels, especially in the context of online delivery. This profoundly affects the level of engagement. Student cohorts prefer to have interactive lectures, or shorter (chunked) lecture slots immediately followed by practical exercises that provide an opportunity for the application of the new information or knowledge. This time proportion model was developed to suit tutorial activities — not to substitute traditional lectures, but rather to be complementary to them.

Figure 1. **Time Proportion Model**



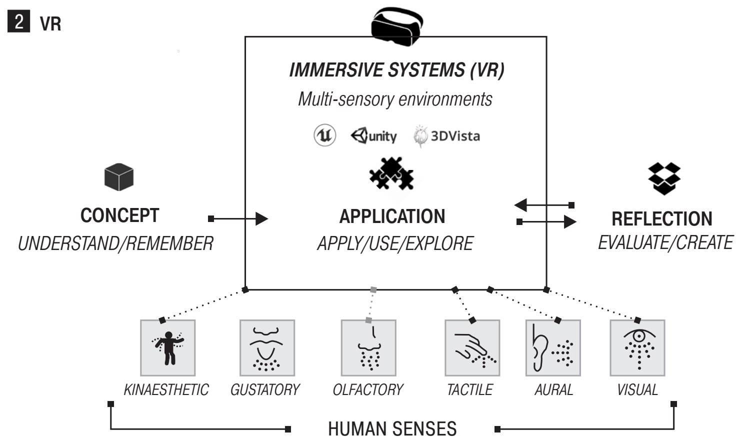
** less than 10 minutes per blocs.*

4.2. Virtual Reality (VR) Integration

Virtual experiences can be developed using several methods. For example, existing physical settings or objects can be recorded with 360-degree camera technology or 3D scanning. These recorded objects and scenery can be used to create immersive environments utilizing gaming engines, such as Unity 3D (2022). It should be noted that the use of gaming engines requires educators to go through extensive software training and is a significant investment in terms of time and effort. This can be very beneficial in the long run, as evidenced by multiple experimental applications [Cheng et al., 2020; Radianti et al., 2020; Wang et al., 2021]. A simpler approach could be using commercially available software such as 3D

Vista (2021) that allows placing images and 3D objects inside virtual scenes. This type of software can be mastered in a couple of hours, as it was originally designed to create virtual walk-throughs for property sales. However, it has much more limited capacity and functionality compared to gaming engines.

Figure 2. **VR Integration**



Both Unity 3D gaming engine and 3D Vista software were used to create learning content for online architecture students during partial integration case studies. This was especially effective for the simulation of site visits, where surroundings were communicated using a combination of 3D models, 360-degree images, videos, and sound recordings [Globa et al., 2019]. The use of this type of technology also supports the integration of gaming aspects and interactions, as well as recording students' progress and automatic data collection. This can be displayed in dashboards as a measure of progress, providing instant feedback to teachers and students [Moloney et al., 2020].

In terms of hardware, the VR experience can be output to a variety of headsets such as Oculus Quest 2 (2022), although it is not realistic to expect that all online students will have access to this equipment. Luckily VR experiences can also be output to personal smartphones using for example Google Cardboard (2021) or experienced (in an albeit limited fashion) using desktop applications instead. It should be noted that in the last two years the VR market has shifted away from developing hardware for smartphone VR towards developing more affordable VR headsets, which allow for superior visual and audio experiences as well as a better response to user movements and interface interactions.

In terms of engagement, VR technology can help mitigate the lack of physical presence, limited sensory feedback, and inability to perform certain physical interactions experienced by online learners [Radianti et al., 2020; Di Natale et al., 2020; Globa et al., 2022]. This is particularly important in the context of learning delivered in such fields as architecture, archeology, and medicine, where physical presence and multi-sensory experiences are a vital part of experiential learning. Scale, sense of place, the roughness of texture, surrounding sounds, smells, etc. can be delivered through new VR technologies incorporating headset clip-on masks to allow users to feel various smells, heat or cold, and even differences in moisture (OVR, 2022).

4.3. Gamification Principles

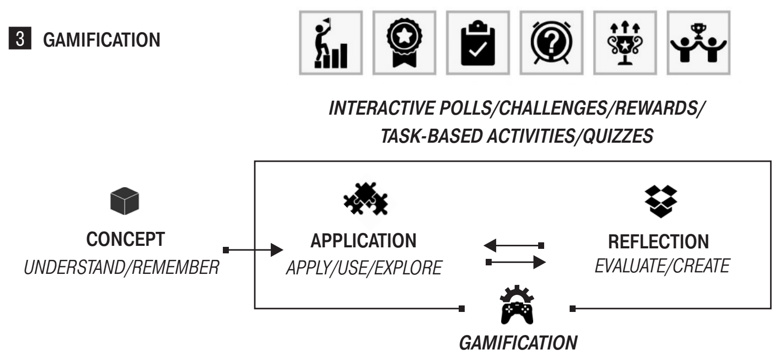
The active engagement components of Bloom's taxonomy such as 'apply', 'analyze', 'reflect' and 'create' (Brookfield, as cited in [Zapalska et al., 2018] can benefit from the use of gamification principles (Figure 3). In the context of education, gamification relates to task and goal-oriented activities such as interactive polls and provides instant feedback in the form of rewards or badges which fosters critical thinking and makes practical tasks more fun and engaging [Campillo-Ferrer et al., 2020].

Previous research shows that giving learners greater autonomy, particularly for the 'reflection' and 'creation' activities, can be extremely beneficial [Smyth, 2011]. We propose to structure gamified learning activities in such a way that the final sections of learning activities would involve peer-to-peer interactions (breakout rooms for group discussions and small group activities) and co-creation of new artifacts such as design objects, questionnaires, or other activities that can be done with various interactive collaborative online tools. For archaeology students, reflection could be consideration of each student's impact on the archeological record in their own environment in a bingo-style game; creation could be making replica archaeological artifacts and comparing their approach and experience in group discussion. An example from architecture might be a synchronous, video-streamed competition using readily acquired materials such as creating the tallest tower from spaghetti and blue-tack. This provides learners with a sense of control and autonomy over the learning experience [Sweetman, 2021; Walker & Koralesky, 2021].

Canhoto and Murphy [2016] provide an outline of how to maximize the likelihood of gamification meeting the aim of improving engagement. This includes consideration of straightforward setup, clear articulation of rules, and evidence of progression. Importantly, there must be recognition of the fact that not all students enjoy the competitive aspect of gamification or are comfortable with a high level of autonomy. Students accustomed to highly structured, teacher-centered instruction may find autonomous activity anxiety-inducing. There is evidence that student anxiety is higher at the beginning of a course, associated with an unfamiliarity with the teaching format (Zambyla, as cited in [Pentaraki & Burkholder, 2017]).

The success of gamification is based on an assumption there is a sense of familiarity of contemporary students with technology. There will always be students who are exceptions to these general rules and assumptions, so it is imperative that students and teachers alike are afforded the opportunity to become familiar with new integrations, such as the design and use of gamified tutorials and VR applications. Additionally, there needs to be a scaffolded approach to autonomy to allow students to build confidence and an understanding of expectations.

Figure 3. **Gamification**



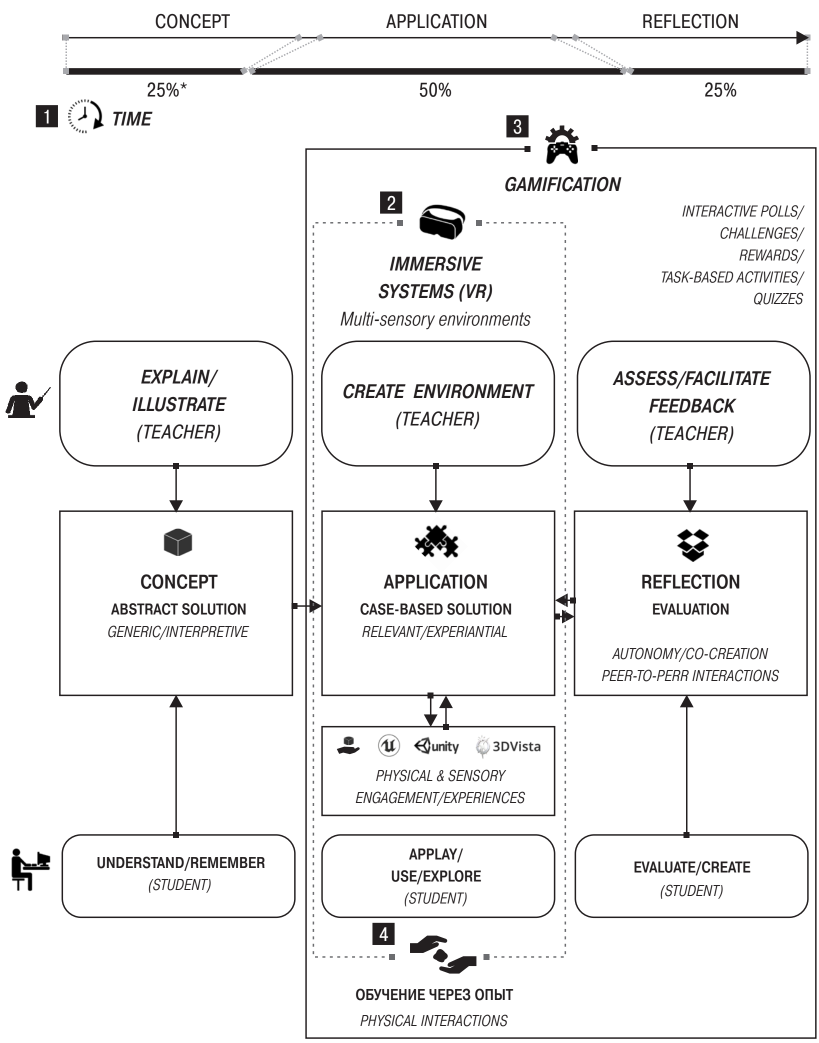
4.4. Physical Experiential Learning

Kolb's experiential learning theory provides the basis for an understanding of learning as a process informed by an individual's own experience and reflection [Kolb, 2014]. Providing opportunities for concrete experience, reflective observation, abstract conceptualization, and active experimentation allows learners to integrate new knowledge into existing understandings. This path of discovery can help learners find an equilibrium between foundational or preceding concepts and new ideas which, if simply presented in a transmissive way, may exist in uncomfortable opposition rather than in an integrated manner that allows further and deepened understanding.

When developing learning tasks on each level it is important to provide students with authentic experiences, so they feel that the activities are worthwhile and relevant, making the contribution of content to learning outcomes explicitly clear to further maximize student motivation to engage with the content [Lister, 2014; Hendrickson, 2016]. From a pedagogical perspective, when developing engaging technologically advanced content it is equally important to consider how tasks will be integrated into a wider educational curriculum within practical disciplines [Radianti et al., 2020].

Colombari, D'Amico and Paolucci [2021] examine the application of small group Challenge-Based Learning in an online environment. Emphasis is placed on the provision of interaction with both peers and teachers, fostering the development of a learning community and providing an opportunity for refinement of skills in communication and collaboration. Additionally, the authenticity or real-life application of the project is important, providing context and relevance. Such challenges could be readily integrated into this novel model, using online platforms designed for remote collaboration, be they virtual breakout rooms in synchronous classes or the use of social apps between tutorials.

Figure 4. **Proposed Hybrid Model (merging 4 key principles)**



* less than 10 minutes per blocs.

Learners can be asked to engage with physical objects that are available to them in their current location. In the context of architecture these can be paper, cardboard, or timber used for physical modeling; or drawing paper, pens, pencils, and watercolors. Thoughtful integration of experiential learning in the online environment could significantly enhance engagement in many disciplines.

Our proposed model combines four key elements together in one hybrid solution: 1) a time proportion model that shifts away from lengthy lectures or explanations and instead prioritizes practical experimentation and application of new information/knowledge and students reflection, shifting the role of the student from passive listener to active doer [Firth, 2020; Sweetman, 2021; Koshti et al., 2022]; 2) integration of VR technology to increase the range of sensory exploration and the level of immersion that is available to the online student's cohorts [Radianti et al., 2020; Di Natale et al., 2020; Globa et al., 2022]; 3) implementation of gamification principles to foster interactivity and allow for greater engagement and fun [Campillo-Ferrer et al., 2020; Budhai & Skipwith, 2017; Sweetman, 2021], and 4) introducing physical experiential learning activities [Kolb, 2014; Lister, 2014; Hendrickson, 2016; Radianti et al., 2020; Colombari & Paolucci, 2021] (Figure 4).

5. Case Studies / Examples of Targeted Integration

5.1. The Implementation of the Time Proportion Model and Gamification

The proposed time proportion model and principles of gamification were implemented for the online and face-to-face tutorials in one of the study units at the School of Architecture, Design, and Planning, the University of Sydney in 2020 and 2022. This study unit is titled 'Architectural Communication 1' and is a core unit undertaken by 170–200 first-year Bachelor of Architecture and Environments students each year. The adjustments to learning activity time proportion were made based on the students' feedback from previous years. Data from the unit of study surveys strongly indicated that both on-campus and online students were keen to have shorter 'bite sized' lectures and more time dedicated to targeted practical tutorials and interactive activities, allowing students to focus on gaining practical skills and engaging in active, rather than passive, learning. Several variations and iterations of the Concept / Application / Reflection time proportion model were used to inform the design of lecture + studio 3.5-hour tutorials. These eventually led to the development of the proposed 25%/50%/25% time model (Figure 1).

The new approach included the delivery of 'mini lectures' that explained the 'concept' and provided new information. The lectures were given live online (via Zoom, 2022) utilizing interactive gamified activities such as polling, open discussions, quizzes, and sketching exercises. The online applications used for these interactive gamified activities included Mentimeter (2022), Canvas (2022), and Miro (2022). The 'application' or practice components of the tutorials took most of the tutorial time and were performed individually by the students. In the context of the study unit these activities were related to the development of the design concept; writing bullet points; sketching design ideas; model-making; or producing bubble diagrams. All practical activities were done through experiential learning, aiming to provide a deeper understanding of the information given during the lectures. The 'reflection' activities were implemented in the final part of the tutorials. These included group discussions centered on tutor-led giving and receiving of feedback on the work that was produced by students during the practice. For the online tutorial setting the reflective and co-design activities were done using Zoom (2022), Miro (2022), and Slack (2022) platforms.

5.2. The Use of Immersive Environments

Two different production pipelines were implemented to develop and test the use of immersive environments: Augmented Reality (AR) and Virtual Reality (VR) for architectural design and architecture in the context of learning and teaching at the university level. This component of the study was done as an offshoot of a larger research project that investigated the affordances of immersive interactive platforms for multi-sensory architectural design and pre-occupancy evaluation of buildings in VR [Globa et al., 2022; Globa et al., 2019]. The AR and VR applications that were developed for these research projects provided the means to create virtual site visits of existing urban contexts and allowed exploration of built or unbuilt architectural spaces (Figures 5 and 6).

The first approach to developing AR and VR applications for architectural design and learning was to use a gaming engine. The output application was conceived and designed as an interactive and highly customizable urban space exploration platform. In terms of the software, the application was developed using the Unity 3D gaming engine (Unity 3D, 2022), with the VR environment and interfaces implemented and output for Oculus Rift and Oculus Quest hardware (Oculus, 2022). The experimental studies progressed in the form of intensive two and three-day workshops and included the development of custom urban settings and design interventions with follow-up presentation and evaluation sessions [Globa et al., 2022]. For each of the three conducted workshops participants carried out group evaluations of the proposed urban events and developed concepts for temporary architectural installations. The participant population consisted predominantly of university bachelor's and master's level students who studied architecture and design. Students were split into separate groups to develop proposed temporary structures for three distinct public events, some of which

Figure 5. **Implementation of immersive environments (VR/AR) developed using Unity 3D (2019–2021)**

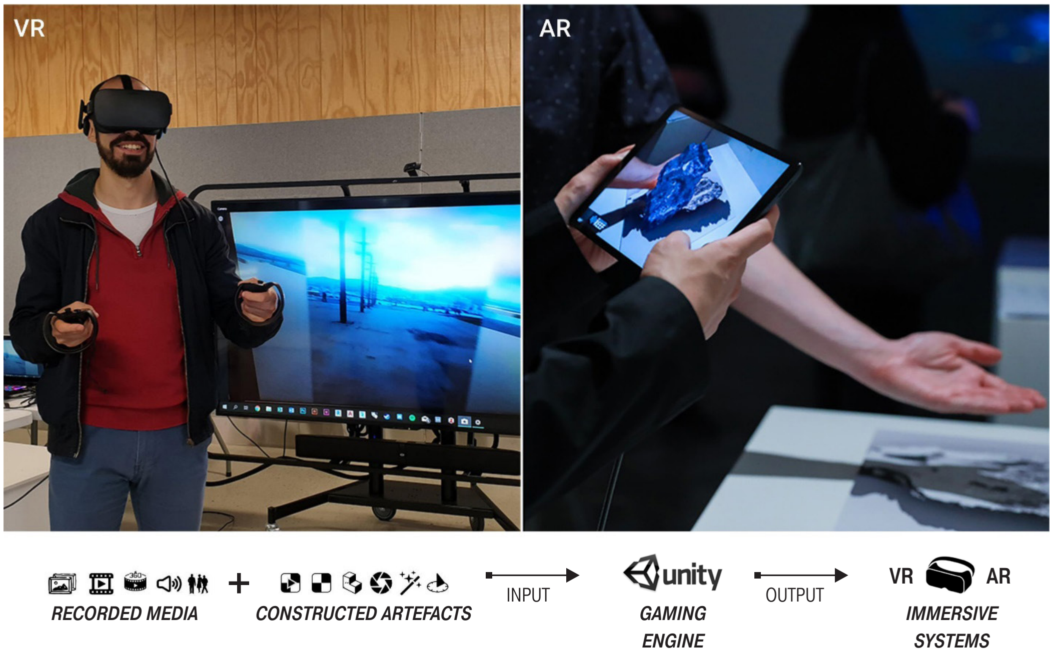


Figure 6. **Actual site visit vs virtual site visit (VR/Desktop) developed using 3DVista (2021–2022)**

were to take place during the daytime and others in the evening. Feedback was collected from the students through face-to-face interviews and online surveys.

Figure 5 details the production pipeline of AR and VR applications using Unity 3D and illustrates possible output results (VR on the right, AR on the left). The pipeline consisted of combining 'recorded media' such as videos, photos, and sounds and 'created media' such as 3D models, animations, and game effects. All types of media are put together using the gaming engine to be output as VR, AR, mobile, or desktop applications.

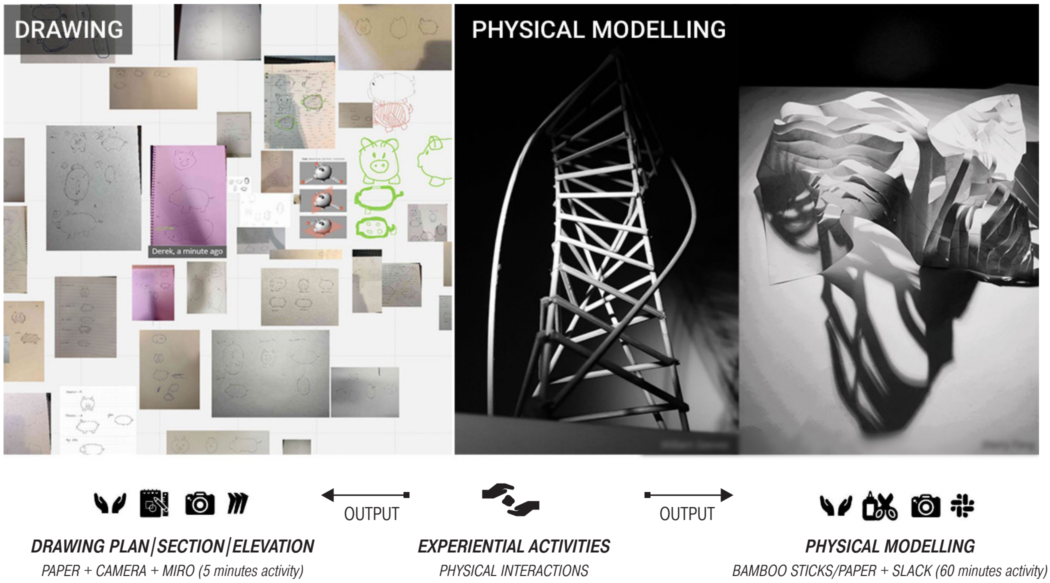
A second approach to creating immersive environments for higher education and allowing online students to perform virtual site visits was to use much less sophisticated software. 3DVista (2021) was used to put together 360 panoramas, videos, and sounds that were recorded on the site of Cadigal Green (Sydney, Australia). Figure 6 illustrates the production pipeline for the output VR or Desktop applications (bottom of the figure) and shows side by side comparison between the site visit activity that was done by the on-campus students of the Architectural Communication unit versus the virtual site visit activity that was provided for the online students in 2021–2022. The resulting virtual site application was output as an environment that allowed users to 'teleport' from one location to the other.

Although gaming engines provide much more flexible and powerful means to create immersive environments, they also require much greater investments in terms of effort and time. Creating a walk-through virtual experience using 3DVista took only a day of work by one professional staff member, whereas creating a sophisticated multi-sensory environment using Unity 3D required multiple weeks of development with two staff members, including a programmer and an artist. Nevertheless, both approaches to creating immersive environments to allow simulated experiences such as site visits, have a high potential and should be considered when designing learning activities for the online student cohorts.

5.3 The Use of Experiential Learning / Physical and Online Interactives

Learning through doing and active engagement with physical objects is an integral part of architectural education. In the context of online learning, the transition from traditional studio / in-class activities such as drawing or model making went relatively smoothly when translated into the 'make it at home' remote learning scenario. Both online and face-to-face students were equally engaged when asked to perform physical experiential activities such as building a structural model out of bamboo sticks or creating a conceptual form-finding model out of a sheet of paper (Figure 7, on the right). Shorthand-drawing exercises or challenges were also imple-

Figure 7. **Implementation of physical experiential learning**



mented as a part of interactive lecture activities. Figure 7 (on the left) shows the results of a 5-minute task, where students were asked to create a plan, section, and elevation of a piggy bank, testing their understanding of new instruction on how to produce orthogonal drawings in architecture.

These physical learning activities were done individually by each student of the Architectural Communication 1 unit and were shared online using Miro (2022) and Slack (2022) platforms. Online sharing of produced learning outputs allowed students to compare the results of their own work in relation to the rest of the cohort. Students' feedback clearly indicates that both online and on-campus learners enjoy engaging with physical objects. This is particularly important for online students as they often feel disconnected and distant, subsequently displaying a lack of engagement and participation in learning activities.

6. Discussion and Future work

In considering the effectiveness of the proposed solution, our response to the identified problem — the lack of engagement of the online students — we need to define a set of metrics for measuring engagement to allow assessment of its success — or otherwise — once fully implemented. This paper explains the theoretical background and rationale behind our proposed method and reports implementation examples of the four principles underpinning our hybrid model for improving student engagement: 1) integration of the time proportion model; 2) the use of immersive environments;

3) gamification and; 4) physical experiential activities. The case studies discussed in this manuscript were carried out in the context of higher education for the discipline of architecture. However, the overall principles of our model are broad enough to be applied to other fields, for example, such fields as archeology and medicine.

More data on the implementation of our proposed hybrid solution applied within varied disciplines and fields is needed in order to compare and analyze its true effectiveness, particularly with respect to improving the levels of engagement in online student cohorts. A number of methods have been suggested to measure engagement in online learning environments. Behavioral engagement could be indicated through reporting on physical interaction with a digital interface such as "clicks". Care must be taken though in interpreting this as an indication of deep learning; students may demonstrate a strategic focus of resources on activities that had a correlation to course grading [Millar et al., 2021]. A clear connection of material with final course outcomes may trigger a willingness to engage with content [Ibid.].

A major benefit of incorporating gamification, including online polling and quizzes (such as Mentimeter), is that these activities not only provide immediate reward and feedback for students but also gather instant data and results for teachers, which can be used to gauge engagement and participation. It is also possible to use gamification statistics, in which instant data can be generated that can gauge engagement and participation.

This study addresses identified online teaching issues by adopting these methods (time-proportion model, VR, gamification, and physical experiential learning) because the overwhelmingly positive feedback from the implementation (proof-of-concept studies) combined with the literature confirms that these methods can lead to improved learning experience for our online students. The literature also suggests that if students are engaged it will facilitate deeper learning. As the only changes to the unit delivery and content were related to the implementation of the 'Hybrid Model' for teaching, we can draw the conclusion that positive feedback received from both students and staff indicates positive overall change. However, it is apparent that future in-depth user studies are required to closely examine and evaluate the relationship between the levels of engagement, student learning outcomes, and the implementation of the Hybrid Model for teaching presented in this manuscript.

As a next of this research project, it is proposed to run a series of targeted workshops to:

1) Evaluate the effectiveness of the VR site visits and the potential of using immersive virtual environments for design studio activities, for example, to better understand qualitative as-

pects of the site context, or place design concepts (3D models or sketches) inside the VR scene. Examine whether and how the use of VR can increase levels of engagement and provide a degree of physical experience as suggested by the literature [Radianti et al., 2020; Di Natale et al., 2020; Globa et al., 2022; Kolb, 2014; Lister, 2014; Hendrickson, 2016; Radianti et al., 2020; Colombari & Paolucci, 2021].

2) Assess different strategies for implementation of gamification principles in different parts of tutorials, particularly for the 'Reflection' component of the tutorial (Figures 3–4). This investigation could focus on differences between the use of different Edtech platforms (imbedded in VR or using online polling for example), anonymous vs non-anonymous feedback, and peer-to-peer or peer-to-tutor interactions [Campillo-Ferrer et al., 2020; Budhai & Skipwith, 2017; Sweetman, 2021].
3) Closely examine strategic time-use, order, and composition of teaching activities, as well as delays between the activities and their relationship to the levels of engagement and resulting learning outcomes [Firth, 2020; Sweetman, 2021; Koshti et al., 2022].

As this proposed model promotes engagement and interactivity for online students, it is especially significant given the ongoing COVID-19 pandemic and associated need to shift teaching delivery to the online mode. The authors encourage any follow-up studies that would use and assess our proposed hybrid model for student engagement, either within or outside of the field of architecture. Our recommendation is to trial this model for the disciplines of archeology and medicine in particular.

7. Conclusion

This project addressed the issue of how to improve engagement and learning experience in online tutorials that have been traditionally taught face to face by delivering more interactivity and a sense of physical presence online. In higher education, such discipline as architecture has traditionally relied on the physical experience to enhance students' learning. According to the survey results, the online students were not as active in-class tasks, including discussions and breakout room activities, compared to the face-to-face students. Whilst the authors are aware that it is not possible to deliver an identical experience to students learning online compared to those students learning face-to-face, the aim of this proposed framework was to explore practical options to improve engagement and replicate as much as possible a sense of the physical experience for the remote learners.

The review of the literature suggested that experiential learning and the use of technology in itself will not produce a quick fix for engagement issues, but rather careful consideration must be made in the delivery and structure of the course content. The use of technology such as VR must be carefully planned to ensure that these tools complement and enhance the teaching with the ultimate goal of supporting motivation, interpersonal connections, and deep learning. For this reason, the proposed solution includes a time-proportion model that includes: 25% of class time be dedicated to instruction/remembering/understanding activities, 50% for active applying/analyzing tasks, and 25% for evaluating/peer-review and co-creating activities that refer to 'reflection'.

For the active applying portion, the proposition was to use gamification to enhance student motivation. Whilst gamification can create a sense of fun, and community and promote participation — as was further proved by the case studies — the literature indicates that competition-style games may not be suitable for all learners and thus should be planned carefully.

Furthermore, virtual reality applications have clear potential to be an effective means of delivering a physical experience for the online students, as implemented for the architecture students. This technology can improve engagement by providing students with immersive educational experiences that can transcend distance, geography, and time. Despite the benefits in terms of improving interactivity, it is important to acknowledge the barriers to using this technology in the current context. The application of VR in classes requires financial investment including the purchasing of software and equipment, the upskilling of teachers, and the additional time needed to train students. As a result, this solution may not be viable en-masse in the immediate future.

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