A Conceptual Framework to Elicit Student Engagement via Development of Extended Reality (XR) Applications Using Project-Based Experiential Learning

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Abstract
Student Engagement is recognized as a covariate of learner outcomes within both online and face to face learning environments. Withal, due to extensive implementation of passive teaching approaches, there is finite guidance about utilization of proactive student-centered teaching strategies to ameliorate engagement among learners like employing Project Based Experiential Learning (PBEL). This paper describes ongoing research to improve multifaceted Student Engagement (Cognitive, Behavior & Emotional Engagement) of learners enrolled in Creative Multimedia Bachelor's degree course, working on their final year projects to develop Extended Reality (XR) applications. To explore how project based experiential learning strategy can be used effectively to engage learners and acknowledging the immanent role emerging XR technologies can play in higher education with a potential to engage learners, this conceptual paper provides a framework for eliciting student engagement via PBEL including XR Technology as an influential factor. As a contribution to teaching practices the framework illustrates student focused approach of experiential learning via project-based learning which can be effectively integrated as a pedagogy in higher education classrooms to increase student engagement, empower learners with 21st Century Skill Set and influence both short and long term academic and social outcomes.

Keywords: Project Based Learning, Experiential Learning, XR Technology, Conceptual Framework

Introduction

Emerging Cross Reality Technology, also known as Extended Reality (XR) immersive Technology is being integrated across different academic fields. XR is a hypernym used for Mixed Reality (MR) technology, Virtual Reality (VR) technology and Augmented Reality (AR) technology (Alnagrat et al., 2022). As the growth, demand and development of the XR is escalating so is the demand for competent immersive technologies designers increasing (Chemerys, Vynogradova, Briantseva & Sharov 2021). Universities across different continents are incorporating interdisciplinary and multidisciplinary courses to empower students with the vital skills to develop and design immersive experiences to attain job opportunities in this growing industry (Chemerys et al., 2021).

To train professional designers the pedagogical component plays an instrumental part as the prime requirement for immersive technologies designers is to garner extensive 21st Century Skill Set. Due to passive teaching approaches and debilitating arduous process of designing and development of immersive technology applications, learners tend to have a low level of engagement (Chemerys et al., 2021). Student Engagement is an indispensable component in academic success for undergraduate students to fulfill the required learning goals and achieve multifarious 21st Century Skill set to be successful in their professional life (Lei, Cui & Zhou, 2018). As a pedagogical solution to the problem of student engagement, this study's conceptual framework proposes the solution of integrating Project Based Experiential learning (PBEL) an amalgam of Kolb's Experiential Learning Cycle (Kolb & Kolb, 2018) and its method of Project Based Learning. Experiential Learning's main goal is to enrich the learning experience and with incorporating the elements of project-based learning (Larmer, Mergendoller & Boss, 2015) students are able to attain the required 21st Century Skill Set mandatory for immersive technology designers to acquire for professional careers in the field of immersive technology.

This paper presents a conceptual framework on how XR technology interacts with constructivist pedagogy of Project Based Experiential Learning (PBEL) and effects student engagement in a higher education context of learners who are involved in exclusive designing of XR experiences as part of their final year project.

Literature Review

Project Based Experiential Learning

Experiential learning theory stems from constructivist learning theory which instigates that the learners develop their own knowledge and skills through active learning processes (Kolb & Kolb, 2018). It commemorates the notion that learning is based upon experience and that the grasping and transformation of that experience lead to knowledge construction and assimilation of new information (Kolb & Kolb, 2018). Related studies show that Experiential Learning provides more opportunities in and out of class participation as well as an increase in interaction among learners which impacts their emotional, cognitive and behavioral engagement (Yusof et al., 2020). To rejuvenate curriculum and enable learners to face challenges, utilization and adoption of Experiential Education by Higher Education Institutions (HEIs) is an ongoing process (Sharma & Naidu, 2020).

Project based learning is one of the many approaches of experiential learning. A typical project management lifecycle is also divided into four main stages, much like an experiential learning cycle. The four phase Project Management lifecycle is applicable and adaptable in project-based learning assignments, projects and environments (Pérez et al., 2020; Spikol et al., 2018). The main elements of the Project Based Learning method namely the challenging problem/question, sustained inquiry, authenticity, student voice and choice, reflection, critique and revision and public product have usually shown to impact SE in a positive way (Larmer, Mergendoller & Boss, 2015). When aligned together, Experiential Learning and Project-Based Learning combine to form Project Based Experiential Learning. Project Based Learning enables learners to become problem solvers, creative thinkers, risk takers and empathetic by cognitively and emotionally engaging them in the learning process (Boss & Krauss, 2022). According to Li, Öchsner & Hall (2019), Project based learning particularly provides educational benefits to improve learning outcomes by allowing design students to effectively design solutions related to real world problems, provides them a meaningful learning experience, motivates them and enables them to attain learner agency as well interpersonal and intrapersonal skill set.

In the context of developing XR immersive technology projects, students go through the Experiential Learning process. In the initial phase of the project students' learning cycle begins with a concrete experience in the form of a theme or a question, which allows them to reflect upon their past experiences and connect their past knowledge with the current problem to solve. During the planning phase of the project which reflects the similar process of the Kolb's learning cycle's phases of reflective observation and abstract conceptualization students get cognitively engaged in curating solutions (Li, Öchsner, & Hall, 2019). Amid the phases of abstract conceptualization and active experimentation, students sort out and start bringing their ideas to life by developing prototypes to test in the active experimentation phase (Li, Öchsner, & Hall, 2019). This is reflected in project-based learning as part of the execution phase during which students develop and manage their project. This elicits their behavioral engagement as well as cognitive and affective engagement as they interact with each other and tools to create content (Li, Öchsner, & Hall, 2019). During the final stage of active experimentation, students test out their developed solutions and through PBL elements of feedback and critique and revision they make final changes before publicly presenting and showcasing their innovation or solution. This marks the closing phase of project development (Li, Öchsner, & Hall, 2019).

XR Technology

XR Technology is revolutionizing higher education by providing learners with interactive learning experiences through virtual interactive simulations and engaging them to be active knowledge seekers. XR Technology implementation in higher education has shown potential transformation in the educational sector (Alam, 2021) particularly in the domains of STEM education (Wang, Ryoo & Winkelmann, 2020), health related faculties, engineering (Ziker, Truman & Dodds, 2021), Bioscience (Harris & Franceschini, 2022) and Design Education (Lee & Hu-Au, 2021). Many universities are leveraging XR Technology availability and getting involved in research allowing design students who are involved in the designing process to create and develop XR Technology experiences (Lee & Hu-Au, 2021). Yet, there is a debate around the effectiveness of XR educational applications as designing immersive technologies for educational context is still an emerging field (Idrees, Morton & Dabrowski, 2022). While XR technology focuses on providing an individual experience, it is now evolving to provide a more social collaborative experience to allow interaction of multiple users in a virtual environment (Marques, Silva, Dias & Santos, 2022).

Human centered design philosophy is the fundamental requirement for designing with XR since it focuses on developing experiences which fulfill human needs, enhance capabilities and allows interactivity and exploration within the virtual environment (Wang et al., 2022). Students who are involved in developing XR experiences readily test their applications during the execution phase of the project which allows them to experience the user experience (UX) factors of XR such as spatial presence and embodiment to get a better sense of what requires to be changed or altered during the development of XR experiences (Shin, 2022). The UX factors of XR engage learners affectively, cognitively and physically as they enable the designers to experience, feel, think and interact with the 3D or virtual environment that they have created providing them comprehensive experience (Crompton, Bernacki & Greene, 2020).

According to Saredakis et al., (2020), Virtual Reality via head mounted display headsets (HMDs) enables users to experience an immersive feeling in a virtual world through interaction with objects designed and displayed in the 3D virtual environments (Wiederhold, 2020). This makes VR Technology to be suitable for teaching and learning purposes as it allows learners to visualize abstract concepts and carry out experiments such as molecular biology or electromagnetics, practice high risk activities or access tasks or experiences which are logistically expensive (Wiederhold, 2020). Research also shows that VR improves design process and spatial perception and allows within the design process, the integration of human experience. Another study conducted by (Kharvari & Höhl, 2019) showed that with VR, architecture students were able to remember the spatial configuration of the building better than studying it through 2D images and drawings. Similarly, study by Özgen, Afacan & Sürer (2021), showed that integrating VR enhanced problem-solving activities among architecture students and enhances learners' engagement levels. AR meanwhile integrates digital information in real time with the user's environment. It enables users to experience over-laid generated information in a real-world environment (Sungkur et al., 2016). Whereas MR amalgamates elements of both VR and AR creating a blended connection between the real world and virtual digital objects (Plecher, Wandinger & Klinker, 2019). Both AR & MR have also shown a positive impact on enhancing student engagement of the learners (Plecher et al., 2019).

Student Engagement

The three-dimensional multifarious model of student engagement shows overlapping across domains of behavioral, cognitive and emotional engagement (Schindler et al., 2017). Each of these three engagements has its own indicators. Positive inclination in those indicators ensues a higher level of engagement among learners. The three main indicators of cognitive engagement include persistence, motivation and deep processing of information (Schindler et al., 2017). Whereas the two main indicators of emotional engagement include a sense of belonging and attitudes, interests and values. While behavioral engagement indicators include interaction and participation in classroom activities and discussions. Cognitive engagement impacts behavioral and emotional engagement, while behavioral and emotional engagement impact each other and cognitive engagement as well (Schindler et al., 2017).

A well-motivated learner feels a sense of belonging, interacts and participates more in the classroom which shows that cognitive engagement impacts both emotional and behavioral engagement (Schindler et al., 2017). Similarly, students who are emotionally engaged in the learning process tend to show higher levels of motivation, persistence and opts for deep processing of information as well as interact and participate more in and out of the classroom

(Gillen-O'Neel, 2021). This shows that emotional engagement has an impact on both cognitive and behavioral engagement. Likewise, the high level of behavioral engagement through active participation in classroom activities and interaction allows students to achieve higher levels of motivation and allows them to share their values, attitudes, and ideas by enabling them to feel a sense of belonging. According to Lerdpornkulrat et al., (2018), motivation and persistence help learners to move forward in the learning process and enables them to face and overcome challenges and obstacles they might come across during learning. Cognitively engaged learners opt for deep learning practices instead of surface learning techniques which help them to acquire new knowledge, explore and broaden their perspectives.

Student engagement is attained when student centered pedagogy interacts with technology, which in this case is XR Technology. Student Engagement is considered a very necessary component in academic achievement as well as enabling immersive technology designer students to develop skills for future professional projects.

Conceptual Framework

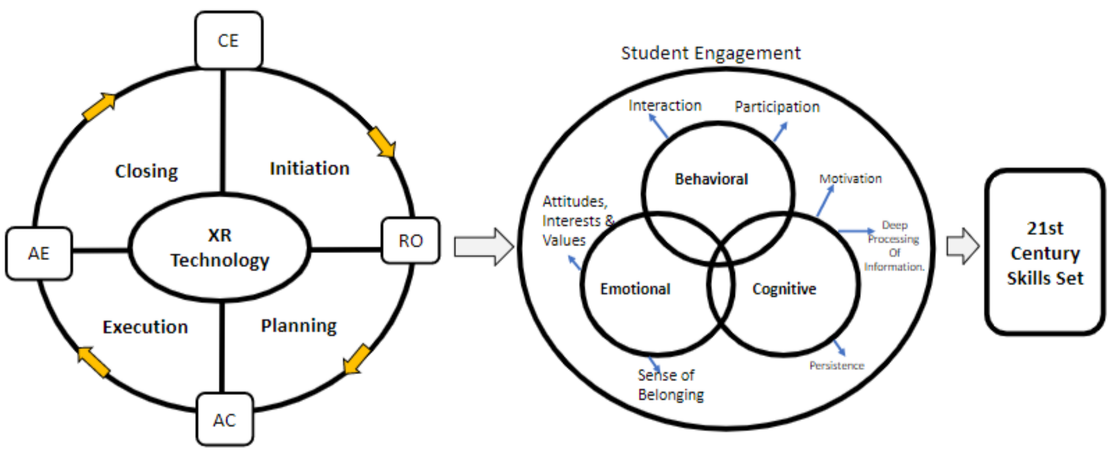

Figure 1: A conceptual Framework to Elicit Student Engagement via Development of Extended Reality XR Applications Using Project-Based Experiential Learning.

The conceptual framework (Figure 1) presented in this paper shows the consolidation of the Experiential Learning Cycle and Project Management Life Cycle with integration of XR technology within its core to elicit student engagement. The four stages of the Kolbs Experiential Learning cycle show the experience learners go through each of the four stages of the project development cycle to develop XR experiences for end users to solve a real-world problem. Student engagement is divided into three domains of emotional, cognitive and behavioral engagement with specific indicators for each engagement (Schindler et al., 2017).

During the initial phase of the project, learners encounter the main problem and begin connecting their prior knowledge to understand and reflect upon the real-world problem. This cognitively engages them to connect their prior knowledge and think about the new problem. During this phase objectives and goals are set for the project (Beneroso & Robinson, 2022). Next, during the planning phase learners establish sustained inquiry practices to find viable solutions to the given problem. They search, gather and classify information, develop a plan, distribute tasks among themselves, engage in open discussion and create initial design blueprints and 3D assets (Beneroso & Robinson, 2022). This phase impacts all three domains of students' engagement. During the implementation phase, learners start developing and testing XR prototypes and make changes through feedback and revision. Throughout the project lifecycle learners actively engage in open discussion with their peers, facilitators, and subject matter experts and stakeholders to work on developing their prototypes (Cha & Maytorena-Sanchez, 2019). Positive feedback and persistence to complete the task motivates learners hence this phase also has a strong potential to increase student engagement and keep learners engaged in the learning and designing process. During the execution phase, final testing and evaluation of the product is completed before presenting the product to the public (Cha & Maytorena-Sanchez, 2019). Learners feel a sense of accomplishment and pride in completing their projects.

Each of the phases of Project Based Experiential Learning Cycle enable learners to develop the required 21st Century Skills Set for the professional immersive technology designer jobs in the future. These skills include technical skills such as 3D Modelling, Animation and Programming Skills. They also develop interpersonal and intrapersonal skills through feedback and revision, communication skills, leadership skills, teamwork skills, language skills, project management and time management skills and research skills (Hennessey & Mueller, 2020).

Conclusion

The conceptual framework presented in this paper is part of an ongoing PhD research which is meant to extrapolate positive impact on student engagement of design students developing XR Technology applications via Project Based Experiential Learning approach. There is a critical need of this research as XR Technology is an emerging technology and new simulations and applications are required for its growth, hence it is important that students who are being trained in their universities attain the required skill sets necessary for professional immersive technology designers to develop innovate and creative experiences for different fields.

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