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Promoting Experiential Learning through Extended Reality Technology

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ABSTRACT: The rapid advancements in technology have transformed the educational landscape, leading to new initiatives for innovative learning. Extended reality (XR), such as virtual reality, augmented reality, and mixed reality, has the potential to redefine teaching and learning methods. Experiential learning is an effective teaching and learning strategy that improves learners' understanding of real-life experiences. This paper aims to discover the ability of XR to promote experiential learning. Thus, a mixed-methods study was conducted with 54 undergraduate students who shared their views on the use of XR in promoting experiential learning. Students were optimistic about the use of virtual tours and a mixed reality (MR) post-it notes application in their learning. Findings from the survey and discussion have highlighted the potential of XR applications in fostering experiential learning among students.

KEYWORDS: Extended reality; virtual reality; augmented reality; mixed reality; experiential learning

1. Introduction

Experiential learning theory has been widely adopted across various academic disciplines, including business management, computer and information science, education, medicine, and engineering [1]. This approach emphasizes learning through direct, real-life experiences, enabling learners to construct knowledge actively rather than passively receiving information [2]. Unlike conventional “hands-on” learning, which focuses primarily on doing, David A. Kolb’s experiential learning theory conceptualizes experience as a dynamic, multidimensional process that integrates reflection, conceptualization, and application [3].

Rapid technological advancements have significantly transformed the educational landscape, introducing innovative approaches that support sustainable education. One such advancement is XR, which encompasses virtual reality (VR), augmented reality (AR), and MR. XR technologies provide immersive and interactive learning environments that enhance student engagement and understanding [4, 5]. In this study, XR technologies are utilized to support and enrich the student learning process.

Various online tools have been employed to accommodate diverse learning styles and teaching strategies. However, simple tools can also have a meaningful impact. Post-it notes, or sticky notes, are one such example, offering practical benefits for both learners and educators. The integration of virtual Post-it notes further contributes to sustainability by reducing reliance

on paper-based materials. Therefore, to facilitate experiential learning, XR-based tools such as virtual tours and virtual sticky notes were incorporated into teaching and learning activities.

XR technologies enable learners to interact directly with the environments and phenomena being studied, rather than relying solely on reading, listening, speaking, or writing. This aligns with the definition of experiential learning, which emphasizes direct engagement with real-world contexts [6]. In contrast, traditional learning methods often limit learners to indirect exposure. Furthermore, the Snap Consumer AR Global Report indicates that AR technology is projected to be used by approximately 75% of the global population by 2025 [7]. Accordingly, this study leverages XR technologies to promote experiential learning while integrating emerging digital innovations to enhance students' overall learning experiences.

2. Literature Review

2.1. Extended Reality (XR).

XR technologies, which encompass VR, AR, and MR, offer unique and transformative solutions in education [8]. According to Au and Lee [8], these immersive and interactive tools can address the educational challenges of the Experience Age by providing learners with engaging, contextual, and experiential learning opportunities. VR offers a distinctive opportunity to create immersive and interactive learning environments that enable learners to actively participate in the learning process [9, 10]. This is due to VR's ability to simulate environments that closely replicate real-world scenarios. In contrast, AR overlays digital information and visualizations onto the physical world, thereby enhancing students' understanding of complex concepts and bridging the gap between theory and practice [11, 12]. Similarly, MR transforms the educational landscape by enabling students to interact with virtual models and visualize complex concepts in a more immersive and intuitive way [11]. According to [13], MR refers to the blending of physical and virtual worlds, creating a new environment in which physical and digital elements coexist and interact in real time.

2.2. Experiential learning.

Experiential learning is a pedagogical approach that emphasizes hands-on experience, which can be significantly enhanced in immersive environments [14, 15]. As the demands of the modern workforce continue to evolve, educational institutions increasingly recognize the role of experiential learning in preparing students to be future-ready [16]. According to [17], one of the primary benefits of experiential learning is its ability to foster problem-solving, observational, and critical-thinking skills.

2.3. Promoting experiential learning through XR technologies.

Scholars have explored both the benefits and limitations of incorporating immersive learning environments into education [18]. The integration of VR in education has attracted considerable attention due to its ability to bridge the gap between online and physical classroom experiences [19]. Furthermore, educators can leverage experiential learning approaches to enhance learners' understanding and better prepare them for the demands of the 21st century [8, 9]. According to Koumpouros [10], AR supports educational practices by enabling concept visualization, gamification, virtual field trips, and simulations of real-world scenarios.

3. Methodology

This study adopted a mixed-methods approach to investigate the benefits of using XR technologies in teaching and learning to promote experiential learning. A mixed-methods design was selected due to its ability to integrate the strengths of both qualitative and quantitative approaches, thereby providing a more comprehensive understanding of the research problem [20]. Qualitative methods enable exploration of contextual and experiential factors, while quantitative methods provide measurable, statistical insights. The combination of these approaches allows for richer data interpretation and more robust findings [20, 21]. Data were collected through both quantitative and qualitative means. Quantitative data were obtained from a course evaluation survey administered after students completed their assessments. The survey gathered feedback on the use of technology in teaching and learning, as well as the achievement of course learning outcomes. Meanwhile, qualitative data were collected through end-of-semester class discussions, where students shared their perspectives on how XR technologies could enhance course delivery. These insights also contributed to the course's continuous quality improvement process.

3.1. Participants.

The participants consisted of undergraduate students enrolled in the Business Fundamentals course, drawn from three academic programmes: Bachelor in Information Technology, Bachelor in Computer Science, and Bachelor in Islamic Revealed Knowledge. The course covers fundamental business topics, including business management, operations management, marketing, human resource management, accounting, finance, and leadership. A total of 54 students participated in the study. As shown in Table 1, the majority of students were from the Bachelor in Information Technology program (n = 36), followed by the Bachelor in Computer Science (n = 11) and the Bachelor in Islamic Revealed Knowledge (n = 7). The cohort included both Malaysian (n = 46) and international students (n = 8). The diversity of participants in terms of academic background, cultural perspectives, and nationality provided valuable insights into different learning preferences and responses to XR-based teaching methods. Incorporating feedback from such a diverse cohort can support improvements in teaching strategies, ultimately enhancing student performance and satisfaction.

Table 1. Demographic details of participants enrolled in the business fundamentals course.

Programme	Total Students	Malaysian Students	International Students
Bachelor in Information Technology	36	31	5
Bachelor in Computer Science	11	9	2
Bachelor in Islamic Revealed Knowledge	7	6	1
Total	**54**	**46**	**8**

3.2. Assessment.

The course assessments were aligned with the course learning outcomes, which also targeted specific domains of the Malaysia Qualifications Framework (MQF) 2.0 and the university's graduate attributes. In this study, the primary assessment was conducted as a group task to foster teamwork and collaboration. The MQF domains addressed include knowledge and understanding, interpersonal skills, communication skills, and digital skills [22]. These

competencies are essential for university graduates and support broader national policy and development goals.

Virtual tours were introduced to support students' learning and assignment completion. These tours provide a safe and controlled environment in which students can explore and develop skills beyond the traditional classroom setting. Through this virtual experience, students can engage with real-world case studies, identify existing problems, experience situational contexts, and propose potential solutions to current business practices with a focus on sustainability. A virtual platform was used to explore sites such as Google Data Center. In addition, devices such as Meta Quest 2 headsets and smartphones were utilized to accommodate student preferences and enhance accessibility. This approach also helps minimize potential discomfort, such as headaches or motion sickness, associated with prolonged use of immersive devices.

In addition, Post-it notes were incorporated to support supplementary learning activities. In this study, a digital Post-it note application based on XR technology was introduced, enabling students to collaborate by sharing, organizing, and interacting with their notes. Unlike traditional paper-based note-taking, XR allows students to create digital notes and place them onto real-world objects within the environment. As students can interact with these notes by editing content and adjusting their spatial placement, this approach aligns with MR applications.

4. Results and Discussion

4.1. Student perception of XR in experiential learning.

Table 2 presents the percentage distribution of students' responses regarding their perceptions of XR in supporting experiential learning using a five-point Likert scale. Overall, the results indicate a strongly positive response from the 54 participants who engaged in XR-based learning activities, including virtual tours and MR Post-it note exercises. Most students selected "Agree" and "Strongly Agree" across key items related to engagement, interactivity, and learning enjoyment. This indicates that XR technologies were generally perceived as effective in enhancing the learning experience beyond traditional classroom approaches. The high level of agreement suggests that students found XR useful in making abstract business concepts more tangible and easier to understand through immersive visualization. In addition, Table 2 shows relatively low levels of disagreement, indicating minimal resistance toward XR adoption among participants. This reflects a generally positive acceptance of immersive learning technologies in higher education contexts. The findings also imply that XR contributes to increased student motivation and active participation, which are essential components of experiential learning [1,2]. International students also contributed positively to the learning experience by sharing comparative educational practices from their home countries. This cross-cultural exchange further enriched classroom discussions and supported innovative approaches to teaching and learning. Overall, the results in Table 2 confirm that XR is perceived as a valuable educational tool that enhances engagement, interaction, and experiential learning outcomes in the Business Fundamentals course.

Table 2. Survey results on students' agreement on the use of VR, AR, and MR in learning.

Quantitative Items	SD (%)	D (%)	N (%)	A (%)	SA (%)
The virtual tour provides the opportunity to experience learning through a virtual environment (360 videos).	0	1.9	18.5	51.9	27.7
Virtual tour promotes collaboration and teamwork	1.9	1.9	27.8	55.6	12.8
Virtual tour allows me to understand and analyse complex real-world situations	0	3.7	14.8	63.0	18.5
MR Post-it notes promote collaboration and teamwork	0	0	9.3	48.1	42.6
MR Post-it notes make my learning more memorable	0	0	13.0	29.6	57.4
MR Post-it notes allow me to reflect my thoughts and ideas	0	0	1.9	77.8	20.3
Both virtual tour and MR Post-it notes app improves my understanding of the course topics	0	1.9	7.4	68.5	22.2
Both virtual tour and MR Post-it notes have boosted my learning motivation and memory	0	3.7	7.4	12.9	76.0
I believe XR could support experiential learning	0	0	3.7	72.2	24.1

4.2. Perceived learning benefits, collaboration, and challenges of XR.

Table 3 focuses on students' perceptions of specific learning benefits and challenges associated with XR, particularly in relation to collaboration, reflection, and usability in educational settings. The findings show that participants strongly agreed that XR promotes collaboration and group-based learning. Students highlighted that VR and AR environments provided effective platforms for discussion, idea sharing, and teamwork. The use of virtual Post-it notes was especially valued as a collaborative tool. Students were able to generate ideas, place digital sticky notes in shared environments, and visually organize collective input in real time. This expanded workspace removed the physical limitations of traditional note-taking methods, such as whiteboards and paper-based systems, thereby enhancing brainstorming and problem-solving.

Table 3. Quotes from a discussion on the use of XR technology in promoting experiential learning.

Positive Feedback	Negative Feedback
• Virtual tours are engaging, fun, and enjoyable to experience. • VR box and VR devices enable realistic, real-world learning scenarios. • Virtual tours enhance understanding of marketing and business operations. • VR allows students to visit distant places without leaving the classroom. • Virtual tours improve understanding of operations management through immersive experiences. • Digital sticky notes improve memory retention of learned content and examples. • VR and AR increase active participation in learning activities. • Digital sticky notes are more sustainable, reducing paper usage compared to traditional post-it notes. • Virtual tours encourage discussion, idea sharing, and brainstorming based on virtual experiences. • The course introduces innovative learning methods through virtual tours and digital notes, enabling exploration of otherwise inaccessible places. • Digital post-it notes in virtual environments enhance understanding and foster critical thinking, making learning more engaging than traditional lectures.	• Virtual tours are more convenient when accessed via smartphones. • VR boxes are useful but not suitable for long-term use. • MR devices (e.g., Meta Quest) are engaging but may cause headaches after short usage. • Virtual tours cannot fully replicate physical interaction with real machines. • There is a lack of sufficient learning materials and content. • Limited number of instructors integrate VR/MR technology into teaching. • VR/MR devices are still expensive and not easily accessible to students. • Few courses currently incorporate VR and MR technologies. • Concerns about potential eye strain compared to traditional or digital note-taking methods.

These collaborative functions were reported to support deeper engagement and experiential learning, where knowledge is actively constructed through interaction and shared understanding [23]. Table 3 also indicates that students perceived XR as beneficial for reflection and contextual learning. Participants agreed that digital Post-it notes helped them capture reflective thoughts, observations, and questions during and after learning activities. For example, students were asked to identify real-world examples of leadership traits outside the classroom, document their observations, and annotate them using virtual sticky notes. This activity strengthened their ability to connect theoretical concepts with real-life situations, supporting reflective learning processes [1, 2].

Furthermore, VR-based virtual tours were found to be effective in providing contextualized learning experiences. Students were able to explore simulated environments such as data centers and historical sites, which improved understanding, engagement, and memory retention. This aligns with the view that immersive technologies enhance learning by situating knowledge in meaningful contexts [24]. However, Table 3 also reveals several challenges. A minority of participants expressed concerns regarding XR usage, including potential health issues (e.g., eye strain), distractions during learning, limited availability of XR content, and the need for adequate instructor training. These issues highlight practical barriers to full-scale XR integration in education and are consistent with previous studies on XR implementation challenges [18, 25]. In addition, students recognized the sustainability benefit of XR, particularly the reduction in paper usage through digital note-taking. Overall, Table 3 suggests that while XR offers strong pedagogical advantages in collaboration, reflection, and engagement, its successful adoption requires addressing technical, health, and instructional challenges.

4. Conclusions

The exploration of experiential learning through VR represents a promising direction for educational innovation and research. Integrating the Post-it notes application into student learning can be a valuable addition to the academic toolkit, offering enhanced opportunities for engagement and collaboration. Experiential learning activities, such as real-life case studies supported by VR and virtual tours, can further help students develop a deeper understanding of the practical application of theoretical knowledge. To effectively implement experiential learning, educational institutions should provide appropriate infrastructure, supportive facilities, and diverse instructional delivery methods. As the world evolves, the demand for future-ready graduates equipped with the skills and experience to address complex challenges will grow. In this regard, experiential learning—with its emphasis on practical application, reflection, and critical thinking—plays a vital role in preparing students for future demands. As the adoption of XR in education continues to expand, it is essential to consider both pedagogical and technological factors that contribute to successful implementation. According to [26], educators must carefully design learning experiences that seamlessly integrate XR into the curriculum, ensuring that the technology functions as a complement rather than a replacement for traditional teaching methods. Therefore, the integration of XR in education has the potential to unlock new possibilities for transformative, immersive learning experiences.

Author Contributions

All authors contributed equally to this work. Each author was involved in the conception and design of the study, data collection, analysis, interpretation of results, and manuscript preparation. All authors reviewed and approved the final version of the manuscript.

Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Where applicable, all datasets generated and/or analyzed during the current study are included in this published article and its supplementary information files.

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