EXPERIENTIAL LEARNING THROUGH 360-DEGREE VIDEO: A POWERFUL TOOL FOR EDUCATORS

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ABSTRACT

STEAM (Science, Technology, Engineering, Arts, and Mathematics) education is at the forefront of innovation, and the integration of immersive technology is revolutionizing the learning landscape. This article explores the transformative impact of using 360-degree video as a powerful educator's tool to enhance experiential learning in STEAM education. 360-degree videos provide an immersive and interactive learning environment that allows students to step inside complex concepts, experience real-world scenarios, and actively engage with the material. The literacy of experiential learning includes Kolb’s concept and immersive technology. Subsequently, it explores adopting the newest learning method with 360-degree technology to connect theoretical and practical knowledge efficiently, offering students a dynamic learning experience beyond traditional methods. A workshop was conducted for teachers, offering insights into the potential benefits derived from the utilization of 360-degree video for experiential learning. Faculty members appreciated the affordability and simplicity of creating Virtual Environment (VE) content, particularly through 360-degree videos. The ease of use enables educators to incorporate VR technology into their teaching practices without needing advanced technical expertise. Furthermore, it examines the challenges and considerations while implementing 360-degree video in engineering education, emphasizing the need for accessible technology, content relevance, and proper integration with curricular objectives. Using 360-degree video as an educator's tool represents a promising path toward enhancing student engagement, improving learning outcomes, and preparing future engineers to thrive in an increasingly complex and technology-driven world.

Keywords: *Experiential Learning, Immersive Technology, 360-degree videos, Virtual Reality, STEAM education*

I.INTRODUCTION

STEAM (Science, Technology, Engineering, Arts, and Mathematics) education is undergoing significant transformations due to the emergence of new technologies. The dynamic nature of engineering fields, with constant advancements and emerging technologies, challenges educators to keep the curriculum up-to-date and relevant. It is also essential to foster critical thinking, problem-solving skills, and collaborative learning to prepare students for the demands of a rapidly changing industry. There is a growing recognition of the need for practical, hands-on experience to align theory and application. There has recently been a growing emphasis on incorporating experiential learning opportunities, such as internships, projects and laboratory work (Berg Steiner, H., Avery, G. C., Neumann, 2010). Although the traditional methods of instruction are foundational, they need to be improved in preparing students for the multifaceted demands of modern practice. This realization has prompted educators, institutions and the higher education sector to explore and include innovative course content and delivery approaches. Specifically, they aim to leverage experiential learning and immersive technologies, like the augmented and virtual reality, across various disciplines to promote understanding, encourage student engagement and increase student satisfaction.

Virtual Reality (VR) content has become crucial in STEAM education, revolutionizing the traditional learning landscape. Engineering concepts, often complex and abstract, can be transformed into tangible, three-dimensional experiences through VR simulations. VR typically requires the leverage of a display, which is head-mounted and other sensory feedback devices to create an immersive experience (Le, Quang Tuan & Pedro, 2015). This technology has applications in various fields, including entertainment, education, and business, and it has the potential to offer users active and engaging learning that can be both entertaining and educational. The fully immersive VR solutions improve the user’s motivation to learn, engage and enjoy several kinds of education and training contexts (Atsikpasi & Fokides, 2021).

Existing research has shown that VR technology allows students to engage in hands-on activities, manipulate virtual objects, and visualize intricate systems, fostering a deeper understanding of theoretical principles (Marougkas, A., Troussas, C., Krouska, A., 2024). Moreover, VR content is instrumental in addressing challenges such as safety training, as it allows students to navigate potentially hazardous scenarios in a risk-free virtual space. The versatility of VR also facilitates remote learning, enabling students to access realistic simulations and collaborate with peers in a virtual setting. Deeper learning may be made possible by the sense of presence that this immersion may produce (Chung, 2012; Falah et al., 2014). As industries advance towards digital transformation, integrating VR in STEAM education not only enhances the quality of training but also ensures guiding the graduates on the difficulties of modern engineering practices approach to preparing the next generation of engineers.

Despite these considerations, VR has struggled to attain broad acceptance and integration within the education sector. It is due to factors such as usability, lack of display or quality, motion sickness, and lack of accuracy in recognition (Noble, S.M, Saville, J.D. & Foster, L.L, 2022). Developing high-quality Virtual Reality content requires specialized 3D modelling, programming, and optimization knowledge. The technical complexity can be a barrier for content creators (Slater & Sanchez-Vives, 2016). The cost of creating VR content, including equipment, software, and skilled personnel, can be prohibitive. This challenge limits the usage of VR accessibility to a broader range of people (Chadwick, 2017). Some VR experiences may need help to provide realistic and intuitive user interactions, limiting the depth of engagement. Improving interactive elements is essential for enhancing immersion (Huang & Shah, 2018).

II. CONCEPTUAL BACKGROUND

EXPERIENTIAL LEARNING IN THE DIGITAL ERA

Experiential learning theory offers a comprehensive model where experience is central to the learning process (Kolb, 1984). The concept of learning through experience is not new. Aristotle, in 350 BC, remarked, "For the things we have to learn before we can do them, we learn by doing them." The experiential learning methodology was later refined and popularized by David A. Kolb, building on earlier work by educational pioneers such as John Dewey, Kurt Hahn, Kurt Lewin, and Jean Piaget.

Modern educators are adopting more effective teaching methods, with experiential learning standing out as a highly impactful approach. Research suggests that up to 90% of the skills required for today's knowledge-based roles are acquired through hands-on experience. Traditional lecture-style teaching, where an instructor addresses a passive audience, is becoming less relevant in an increasingly digital world (Johnson, C. D., 2018). By fostering active participation and immersive learning, educators can significantly enhance students' growth, equipping them with both theoretical knowledge and practical expertise. Figure 1 illustrates Kolb's cycle of experiential learning.

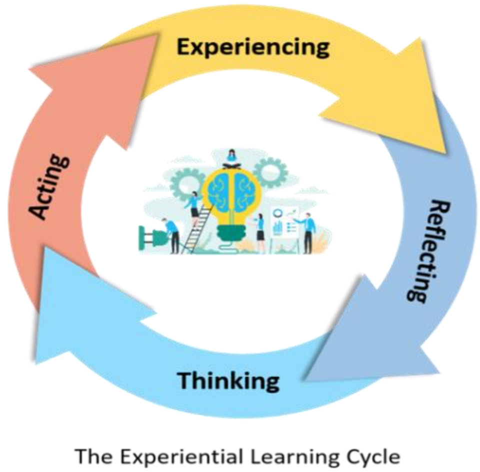

Figure 1. The Experiential Learning Cycle by Kolb

The educator conducts a hands-on, direct experience about the experiential life cycle, such as a lab experiment, field trip, or role-play, and then plans individual or group reflections. Understanding the event's significance is the primary goal of the conceptualization phase, which frequently involves reading or attending lectures on relevant topics. The next step requires learners to apply their knowledge to their personal and professional environments.

Education in the digital age has embraced continual evolution, integrating the numerous opportunities presented by technological advancements. Innovations such as remote and virtual laboratories, robotic systems, 3D virtual environments, augmented reality tools, sophisticated data visualization techniques, and mobile applications are transforming teaching methodologies. These technologies support approaches like problem-based learning, case-based learning, and online education. Collectively, they contribute to a more dynamic, student-centered approach, particularly in the field of engineering education (McGovern, Enda, & Moreira et al., 2019).

IMMERSIVE TECHNOLOGY

Immersion technology allows for the learning and refinement of new skills and practices by providing artificially manufactured digital settings and content that faithfully mimic real-life circumstances. Students receive the opportunity to be active participants who directly impact results rather than just passive viewers. It provides a risk-free, secure environment where learning may be replicated and achievement precisely quantified. It is learning through practice in which the only limitation is the sky (Argyriou, L. 2020 and Florian Wehking, M. W. 2019).

Immersive technology can revolutionize experiential learning by providing engaging and interactive experiences. Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) can develop realistic simulations that mimic real-life scenarios, allowing learners to actively participate and learn by doing (Jorge Alvarez, R. R. 2020). This hands-on approach enhances understanding and retention.

The different types of immersive technology provide unique benefits in several approaches in the education sector. These include:

Virtual Reality (VR) lets students immerse themselves completely in digitally created environments. Learners can navigate and interact within these virtual spaces using VR headsets such as the HTC Vive or Oculus Quest, often accompanied by headphones and hand controllers (Konstantinos Koumaditis, F. C., 2019).

Augmented Reality (AR), on the other hand, integrates virtual elements into the real world, creating an interactive overlay that blends digital content with the physical surroundings. This interaction is typically facilitated through smartphone applications or wearable smart glasses, allowing users to engage with the augmented environment in real-time.

Mixed Reality (MR) connects digital elements and the real world. Using the next-generation technologies related to imaging and sensing, MR can handle both virtual and physical items. MR helps see and immerse in the surrounding world and aids in interacting in a virtual platform using gestures via wearable glass like Microsoft Halo lenses (Lemonia Argyriou, D. E. 2016).VR, AR, and MR are examples of real and virtual worlds that fall under the general category of "extended reality" (XR).

360 degree - A small section of 360 content helps learners choose what they want to look from the photo or video with a mouse, controlling the viewing angle by moving their phone or trackpads (Alvita Ardisara, F. M. 2018). The experience is only partially immersive as it is watched on a computer or phone. With a headset or Head-Mounted Device (HMD), one can watch 360 content for a more immersive experience, but the video looks flat without feeling the depth. Most of the 360 videos are monoscopic. (Chareen Snelson, Y.-C. H. 2019).

3D-360 - 3D -360 employs stereoscopic techniques to create the illusion of depth, and the headset is used to watch the video to perceive the depth. Due to cameras made expressly to record stereoscopic footage, most 360-degree recordings are monoscopic. Three hundred sixty videos are higher in price. (Kyoungkook Kang, S. C. 2019). To enhance monoscopic 360-degree video and produce a stereoscopic version of a video with sensory depth, production skills, including extra 3D scanning hardware and software, such as Matterport or Cpix360, are needed.

VR Video - 360 VR and VR Video are practically synonymous. They speak about films recorded with specialised omnidirectional cameras allowing simultaneous 360-degree filming. Actual virtual reality must include an immersive component, which calls for using a headset. Providing users with mobility, or degrees of freedom (DoF), is a fundamental component of virtual reality. Three degrees of freedom, or the capacity to move the head around while consuming content, is 3DoF. Six degrees of freedom, or 6DoF, is the capacity to adjust the head and body position while interacting with material. Effective 360 or VR content attempts to strengthen the presence of the mind for the users, giving a realistic and natural feel (Ahmed Elmezeny, N. E., 2018).

Unlike computer-generated environments, 360-degree video is captured in real-life settings. These videos and images simultaneously record and display every angle, providing a comprehensive view. While this content can be accessed through VR headsets, immersing learners in the environment, their experience is limited to the filmmaker's perspective (Maria Grazia Violante, E. V., 2019). This means learners can look around by moving their heads but cannot interact with or navigate the environment independently, reducing interactivity. Nevertheless, 360-degree videos are an excellent way to introduce students to virtual field trips, construction site visits, and other experiences without requiring them to leave the classroom

III. LEVERAGE 360–DEGREE VIDEO IN STEAM EDUCATION

The role of immersive technologies, particularly 360-degree video, in STEAM education is pivotal in educating students to face the difficulties and demands of the current engineering environment (Shadiev et al., 2021). These immersive videos create authentic learning environments and offer multi-perspective viewing options (Shadiev et al., 2021; Rosendahl & Wagner, 2023). In surveying engineering education, 360-degree videos have prepared students for outdoor labs, improving their understanding of surveying methods and equipment operation (Bolkas et al., 2020).

Enhanced Immersive Learning Experiences

Headsets with cutting-edge display technology, superior processing power, and advanced sensors offer an unparalleled immersive experience. For engineering education, this means the ability to create highly detailed and realistic simulations of engineering environments, from construction sites and manufacturing plants to intricate machinery and systems. Students can virtually step inside a machine to understand its workings or walk through a construction site to learn about structural engineering principles without leaving the classroom (Lemonia Argyriou, 2017).

Interactive and Engaging Learning

The interactivity enabled by such advanced headsets transforms passive learning into an active exploration. Students can manipulate virtual objects, conduct simulated experiments, and test their designs risk-free. This hands-on approach deepens understanding and retains student engagement, making complex engineering concepts more accessible and easier to grasp (Shadiev et al., 2021). Studies have shown that 360-degree video content can increase student engagement, immersion, and motivation compared to traditional 2D learning methods (Kim et al., 2022).

Collaboration and Remote Learning

With the global shift towards remote learning, 360-degree headsets can bridge the gap between physical and virtual classrooms (Romain Christian Herault, A. L.-S. 2017). It enables collaborative projects where students can work together in a shared virtual space regardless of physical location. This fosters teamwork and communication skills, essential competencies for future engineers.

Accessibility and Customization

Educators might find it easier to create or access tailored 360-degree video content that aligns with their specific curriculum needs, making immersive learning more widespread and accessible (Johannes Sauer, J. S. 2017).

Real-World Application and Innovation

The benefits of 360-degree videos in education include increased learning motivation, authentic learning scenarios, immersive experiences, multi-perspective observation opportunities, and individualized learning (Rosendahl & Wagner, 2023). Students can apply theory knowledge in real-time by simulating real-world engineering challenges and environments, improving their problem-solving ability and readiness to work. Moreover, exposure to the latest technology trends inspires innovation and creativity, encouraging students to explore new solutions and technologies in their future careers.

Overall, 360-degree videos show promise as an effective tool for enhancing STEAM education and other disciplines.

IV METHODOLOGY

A 4-week course on Educational Media Production for E-Learning was held, in which a one-day workshop, “360-degree VR Immersive Content Creation for Educators”, was organised, focusing on the production of 360-degree videos and their visualization using Virtual Reality (VR) Head-Mounted Displays (HMDs). The workshop provided delegates with hands-on experience in creating immersive content, allowing them to explore the nuances of 360-degree video production. The workshop was attended by 32 teacher participants from 30 countries representing various ideologies and backgrounds. The workshop was well-received, with delegates gaining valuable insights into VR video production's technical and creative aspects.

During the workshop, teacher participants were engaged in hands-on training sessions to comprehend the process of creating 360-degree video content. Instructions were provided to them on the technical aspects of filming, editing, and producing immersive videos (see Fig.3). The process for creating a 360-degree Video for Experiential Learning is given in Figure 4. Additionally, teachers were provided with VR headsets to view 360-degree content, enabling them to experience the immersive environments themselves, as shown in the figure. Figure 5 is the image of the 360-degree video visualized by the workshop participants through the Virtual Reality headsets.

Figure.2. Participants learning how to film a 360-degree video

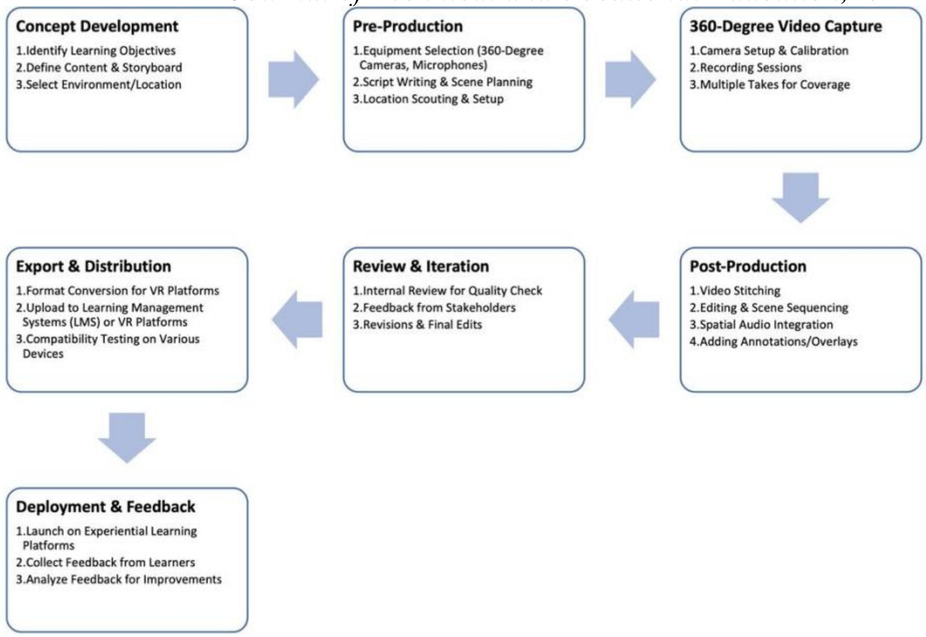

Figure 3. Creating a 360-degree Video for Experiential Learning

Figure 6. Participants wearing VR headsets to experience 360-degree video

Following the workshop, we gathered oral and written feedback from all teacher participants to capture their experiences and perspectives. The feedback revealed a high level of enthusiasm and acceptance among the attendees regarding using 360-degree videos as a tool for experiential learning.

Findings:

Cost-Effectiveness & User-Friendliness

- Participants appreciated the affordability and ease of creating VR content using 360-degree videos.
- Highlighted the potential of 360-degree Video through VR technology in enhancing education and training.

Preference for Short Videos

- Participants favored videos with a duration of fewer than 3 minutes.
- Shorter videos are more engaging and effective for learning.

Boost in Confidence

- Positive feedback encouraged participants to adopt 360-degree videos for immersive learning.
- Strong potential recognized for STEAM education, emphasizing experiential learning.

V. CHALLENGES AND CONSIDERATIONS FOR USING 360-DEGREE VIDEO IN EDUCATION

Integrating 360-degree video into educational practices presents unique challenges and considerations that span technological, financial, and pedagogical domains.

Technological Challenges

- Infrastructure Requirements: Schools need robust IT infrastructure, including computers with graphics cards, 360 Insta cameras for recording, and compatible devices for video editing.
- Technical Support and Training: Educators require training to create 360-degree videos.

Financial Challenges

- Equipment Costs: Recording and viewing 360-degree video requires specialized cameras, VR headsets, or compatible devices, which may strain educational budgets.
- Maintenance and Upgrades: Regular updates and maintenance of devices and software add to ongoing financial commitments.

Pedagogical Challenges

- Curriculum Integration: Embedding 360-degree videos into lesson plans requires careful planning to align with educational goals and enhance learning outcomes.
- Engagement vs. Distraction: While immersive, 360-degree videos may distract learners if not designed with a clear educational focus.

To overcome these challenges, a strategic approach involving investment in resources, training, and collaboration between educators and technologists is crucial. Thoughtful integration of 360-degree video can significantly enrich educational experiences and foster deeper engagement.

VI. CONCLUSION

Integrating 360-degree video in STEAM education represents a significant leap forward in experiential learning, offering immersive, interactive learning environments that bridge the gap between theory and practice.

Despite its potential, adopting 360-degree video and immersive technology faces technological, financial, and pedagogical challenges. These include the need for high-quality content development, hardware integration, curriculum alignment, and overcoming barriers related to cost and accessibility. Moreover, the effectiveness of these technologies in improving learning outcomes and student engagement necessitates further empirical research.

This paper emphasizes the transformative potential of 360-degree video in education while advocating for sustained innovation, research, and collaboration to address challenges and enrich the learning experience for future generations.

Acknowledgements

The author would like to sincerely thank **Prof. M. Manivannan** from the **eXtended Reality and Haptics Innovation Center (XTIC), IIT Madras**, for his invaluable guidance and support throughout the workshop and study.

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