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Transformative Learning: Integrating Extended Reality into Outcome-based Education in Higher Education

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Abstract

Outcome-based education (OBE) represents a paradigm shift in educational practices, emphasizing the achievements and competencies learners should demonstrate upon completion of a learning experience. By inherently aligning the educational system with specific learning outcomes, OBE enables educators to personalize and adapt instruction to meet diverse student needs. The integration of Extended Reality (XR) technologies—encompassing Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR)—presents an innovative avenue to enhance learning experiences within this framework. Through systematic literature approach, this paper explores the principles underpinning OBE, the challenges inherent in its implementation alongside XR technologies, and the transformative outcomes in higher education. This paper aimed to help instructors to understand how they can embrace OBE into practical action by integrating XR. This could guide the instructors in their course planning, including teaching and assessment planning. This paper does not attempt to be a complete guide on OBE, rather it introduces some initiatives on how XR technology could support OBE. single lines pacing. The incorporation of Extended Reality within an Outcome-Based Education framework has the potential to revolutionize learning experiences in higher education. By explaining the principles of OBE, addressing implementation challenges, and recognizing the transformative outcomes of this integration, educators can create immersive learning environments that not only cater to diverse learners but also prepare them for real-world challenges.

Keywords: Extended Reality (XR), Outcome-Based Education (OBE), Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR)

Introduction

The integration of extended reality into outcome-based education within higher education represents a paradigm shift in pedagogical approaches, promising to enhance learning experiences and improve educational outcomes (Cabero-Alemanra & Dí-az, 2017). Extended reality, encompassing virtual reality, augmented reality, and mixed reality, offers immersive and interactive environments that can revolutionize the way students engage with educational content (Kazu & Kuvvetli, 2023). Augmented Reality (AR) is at the forefront of

technological innovation, with its ability to overlay digital content onto the physical world, offering innovative opportunities to enhance learning experiences and transform traditional pedagogical approaches (Palada et al., 2024). AR is viewed as a catalyst for online education, providing attractive and motivational educational experiences grounded in real-world applications (Cabero-Alemanra & Dí-az, 2017). As online distance education evolves, meta-education and metaverse-powered platforms are emerging, creating hybrid learning experiences within online 3D virtual environments, addressing the need for interaction and integration between the virtual and real worlds (Suh et al., 2023). Virtual reality (VR) emerges as a powerful tool in education, offering three-dimensional digital environments that stimulate both visual and auditory senses, thus enriching psychological and physical experiences through cutting-edge technologies, transforming the educational landscape and innovating pedagogical methodologies (Cabrera-Duffaut et al., 2024). The integration of extended reality technologies aligns well with the principles of outcome-based education, which emphasizes the achievement of specific learning outcomes and the demonstration of competencies. Metaverse appears as a meaningful solution by integrating state-of-the-art technologies such as virtual reality and augmented reality, artificial intelligence and cloud computing to make educational activities more attractive (Wang et al., 2022). The increasing popularity of virtual reality technology for non-educational uses is making it more familiar to students, while growing student motivation is one of the primary forces driving the introduction of virtual reality technology into the educational process (Ely, 1992).

In educational settings, students often encounter comprehension difficulties stemming from the complexity and abstract nature of certain concepts, which necessitates a shift towards innovative tools that cater to diverse learning needs (Kamińska et al., 2019). The metaverse provides visualized and decentralized learning resources, enabling learners to interact with the material in new ways (Zhang et al., 2022). VR can transform abstract concepts into tangible, explorable environments, while AR enhances the learning process by overlaying digital information onto the physical world, and mixed reality seamlessly integrates virtual and real-world elements to create dynamic and interactive learning experiences (Vert & Andone, 2019). The Metaverse can also provide simulations, game-based learning, and virtual field trips, making learning more engaging and interactive (Kabilan, 2023; Kaddoura & Husseiny, 2023). The metaverse offers an unprecedented opportunity for collaborative learning by allowing students to interact with peers and instructors in virtual spaces, regardless of geographical location. Moreover, the metaverse is unlocking amazing learning activities for learners, which enable them to perceive, explore, and create the world in innovative ways, allowing students and teachers to break free from the restrictions of time and location (Zhang et al., 2022). Students can participate in group projects, discussions, and problem-solving activities within these virtual environments, fostering teamwork, communication, and critical thinking skills (George & Wooden, 2023). In addition, the Metaverse facilitates personalized learning experiences tailored to individual student needs and preferences. The utilization of the metaverse for education is full of possibilities and unlimited (Suh et al., 2023). Curricula can easily fall behind, but the Metaverse has the power to turn the entire world into a virtual global school (Kaddoura & Husseiny, 2023).

Literature Review

Extended Reality in Education

The transformative potential of extended reality (XR) in education lies in its capacity to create immersive, interactive, and personalized learning experiences that cater to diverse learning styles and needs. It is characterized by persistence, interactivity, and embodiment, and the use of the metaverse in educational and training processes is gaining ground (López-Belmonte et al., 2023). Virtual reality (VR) is enabling a hyper-realistic and immersive experience and augmented reality offers attractive and motivational educational experiences grounded in real-world applications (Yu et al., 2023) (Wang et al., 2022). Moreover, XR technologies can facilitate collaborative learning experiences, allowing students to interact with peers and instructors in virtual environments, fostering teamwork, communication, and problem-solving skills (Hong et al., 2022).

In this realm, VR is a three-dimensional digital environment that stimulates both visual and auditory senses, while AR overlays digital content onto the physical world, enhancing learning through interaction with real and virtual objects. VR environments also reduce distractions and increase attention spans, which can lead to more interactive and experimental technology education (Onele, 2020). Furthermore, VR is seen as an innovative response to the challenges that distance learning has posed by Drakopoulos and Sioulas (Drakopoulos & Sioulas,2021). The immersive experience offered by virtual reality in the classroom is highly engaging and motivating for students, with proven advantages in numerous experiences and research (Rodríguez, 2024). Students are able to better understand the subject and engage with the learning material when they are given a unique perspective (Marougkas et al., 2023). By combining keywords, the comprehensive nature of the survey becomes apparent and the development of virtual educational environments with interactive capabilities, designed through the web, ensures the creation of immersive and multi-sensory 3D environments (Barráez-Herrera, 2022).

Outcome-based Education

Outcome-based education is a learner-centred approach that focuses on what students should know, understand, and be able to do as a result of their learning experiences. Its core principle emphasizes the importance of defining clear and measurable learning outcomes that align with the needs of students, employers, and society as a whole. The learning methodologies that have the greatest effect on current educational systems are those that present students with a specific problem they have to solve using acquired theoretical knowledge or through improving students' capacities that are non-existent or underdeveloped until that moment (Drakopoulos & Sioulas, 2021). The shift towards outcome-based education signifies a move away from traditional, teacher-centred approaches that prioritize content coverage over demonstrable skills and competencies (Calvet et al., 2019). Through the use of virtual reality environments, students are encouraged to be more proactive in their learning activities, taking charge of their educational journey. By focusing on outcomes, educators can design instruction and assessment methods that are more relevant, engaging, and effective in preparing students for success in college, careers, and citizenship.

The incorporation of extended reality technologies into outcome-based education holds immense potential for enhancing student learning and achievement. This method fosters self-

directed learning and experiential discovery (Mendolia-Moore, 2023). Students are given opportunities to apply their knowledge and skills in real-world contexts, which promotes higher-order thinking skills such as critical thinking, problem-solving, and creativity (Chimakurthi, 2018). By providing students with opportunities to apply their knowledge and skills in immersive, interactive environments, extended reality can help them develop a deeper understanding of complex concepts and improve their ability to transfer learning to new situations. Furthermore, the use of virtual reality and augmented reality applications in education has the potential to promote inclusivity and equity by providing access to learning experiences that may not otherwise be available to all students.

Methods

The study employs a systematic review and content analysis approach, focusing on existing literature in academic databases. A systematic review aims to provide a comprehensive summary of the existing literature relevant to a specific research question, which is invaluable for professionals and researchers alike (Jahan et al., 2016). Regardless of the specific type of literature review, it remains important for authors to critically evaluate and analyze the relevant body of work in their respective fields (Bolderston, 2008). Content analysis, a multifaceted research technique, is systematically employed to examine and interpret various forms of communication, encompassing textual, visual, and auditory materials. It serves as a powerful tool for researchers seeking to discover patterns, themes, biases, and meanings embedded within data (Whitaker, 2011). Content analysis enables researchers to systematically test theoretical propositions and deepen their understanding of complex development (Cavanagh, 1997). The aim is to synthesize findings and explore trends related to educational technologies and outcome-based education. The primary resources for this study are Scopus and Web of Science (WoS), known for their comprehensive collections of peer-reviewed journals and conference papers. The search strategy includes keywords, search fields, date range, and language is presented in Table 1. The inclusion criteria include study that directly address any of the keywords, published in peer-reviewed journals or conference proceedings, focusing on educational outcomes, while the exclusion criteria refer to articles that are not related to education, or those focusing only on technical developments without educational implications. For the data collection, this study collects and export data, including titles, authors, abstracts, publication dates, and journals into EndNote.

Table 1
Search strategy

Search strategy	No. of Publications
Keywords	outcome-based education", "extended reality", "virtual reality", "augmented reality", and "mixed reality"
Search Fields	Utilize these keywords in titles, abstracts, and keywords of articles.
Date Range	2014-2024
Language	articles published in English to ensure consistency.

For the content analysis, a coding framework has been developed based on the themes related to outcome-based education and extended reality technologies. Codes include implementation strategies, challenges, sand student outcomes. In addition, thematic analysis was conducted to identify common themes or patterns across the literature, specifically related to the impact and integration of technology in educational settings. For the data

synthesis, this study summarizes the findings, identifying gaps in the literature, emerging trends, and areas for future research. This synthesis provides insights into how extended realities can support outcome-based education. To ensure consistency in content analysis by carrying out inter-coder reliability checks.

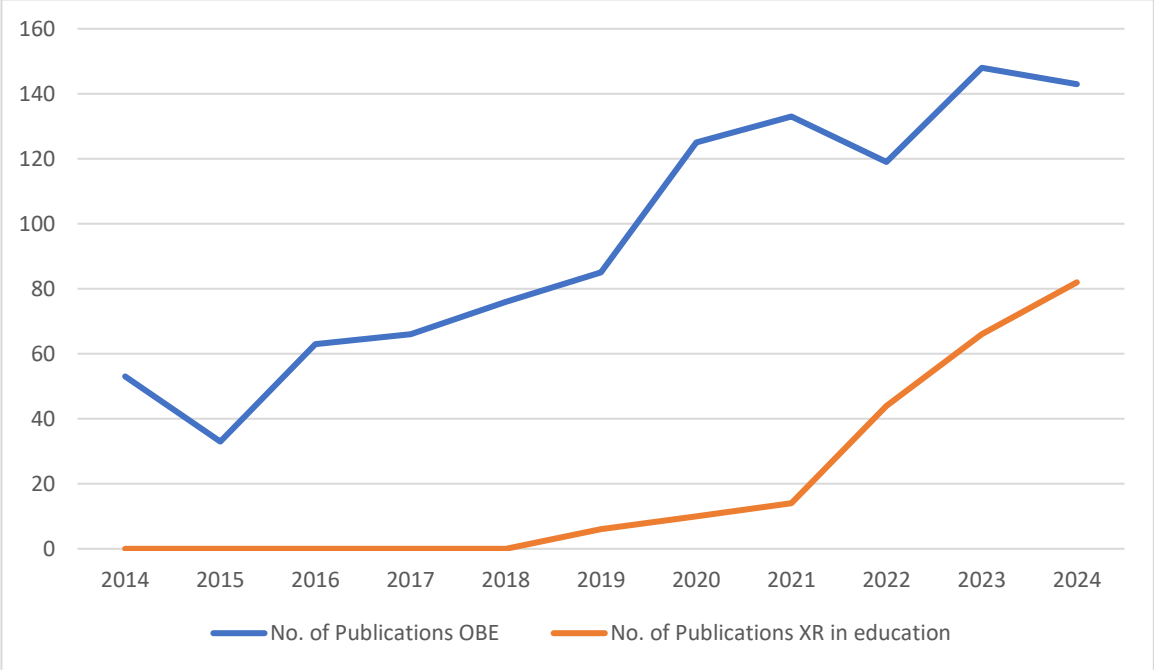

Figure 1. Publications by year

Figure 1 reflect the development of academic study on the topic outcome-based education and extended reality in education. Based on the graph, both OBE and XR in education have gained researchers' interest. Still, the is limited number of studies that focus both OBE and XR. Therefore, there is a need to discover the potential of extended reality in transforming learning to outcome-based education.

Results and Discussions

OBE Principles

Outcomes-Based Education represents a paradigm shift in educational philosophy, moving away from traditional, teacher-centred approaches towards a student-centred model that prioritizes what students know and can do upon completion of their educational experiences (Tam, 2014). At its core, OBE is a system where the curriculum is systemically designed and organized to facilitate the achievement of clearly defined learning outcomes, encompassing the knowledge, skills, and attitudes that learners are expected to demonstrate (Riwayadi & Yohana, 2021). These outcomes serve as the driving force behind all decisions related to curriculum design, instructional strategies, and assessment methods (Rao, 2020). The emphasis on outcomes ensures that education is relevant, meaningful, and aligned with the needs of both students and society, fostering continuous improvement and a commitment to excellence (Zhang et al., 2022). The establishment of well-defined learning outcomes is paramount in OBE, dictating the desired competencies and capabilities of students upon program completion (Mehdi & AbouNaaj, 2013). These outcomes should be specific, measurable, achievable, relevant, and time-bound, providing a clear roadmap for both educators and learners (Pradhan, 2021). A well-structured OBE model necessitates a comprehensive strategy, encompassing a clearly defined mission and vision statement,

program outcomes, and course outcomes, all aligned to achieve the desired educational results (Sathya, 2021).

One of the fundamental principles of OBE is its focus on student-centred learning, which entails creating an environment where learners are active participants in the learning process, taking ownership of their education, and constructing their own understanding of the subject matter. This is achieved through the implementation of active learning methodologies, that encourage student involvement and participation, moving away from the passive reception of information in traditional classroom settings (Prasad et al., 2020). Teachers transition into facilitators, guiding students through the learning process, providing support and resources, and fostering critical thinking and problem-solving skills (Lu, 2019). Another key principle of OBE is its emphasis on continuous assessment and feedback, which involves monitoring student progress regularly and providing timely feedback to guide their learning journey. Assessment is not merely an end-of-term evaluation but an integral part of the learning process, providing valuable insights into student understanding and informing instructional decisions. Formative assessment techniques, such as quizzes, discussions, and projects, are used to track student progress and identify areas where additional support is needed. Summative assessments, such as exams and final projects, evaluate overall learning and achievement. Furthermore, OBE's flexible nature empowers educators to adapt their teaching methods and curriculum to meet the diverse needs of students, while the emphasis on participation encourages students to take initiative in their learning (Park, 2023; Wang, 2021).

OBE Challenges

Effective implementation of OBE requires significant changes in instructional design, assessment practices, and the overall educational culture. One of the common challenges is resistance to change from faculty members who are accustomed to traditional teaching methods (Mohamad et al., 2019). Overcoming this resistance requires providing adequate training and support to faculty, demonstrating the benefits of OBE, and involving them in the design and implementation process. Another challenge lies in the development of appropriate assessment methods that accurately measure student achievement of the desired learning outcomes, requiring educators to move beyond traditional exams and quizzes to incorporate performance-based assessments, portfolios, and other authentic measures. Ensuring alignment between curriculum, instruction, and assessment is also crucial for successful OBE implementation, necessitating a cohesive and integrated approach to education.

Addressing these implementation challenges requires a comprehensive and collaborative approach involving all stakeholders, including faculty, students, administrators, and employers. Providing ongoing professional development and support to faculty is essential to equip them with the knowledge and skills necessary to implement OBE effectively. Creating a culture of collaboration and shared responsibility among faculty members can also facilitate the implementation process. Additionally, involving students in the design and evaluation of OBE programs can enhance their engagement and ownership of their learning. Furthermore, establishing strong partnerships with employers and industry representatives can ensure that OBE programs are aligned with the needs of the workforce and that graduates are well-prepared for their future careers.

Integrating Extended Reality into Outcome-Based Education

The integration of extended reality (XR) into outcome-based education represents a paradigm shift in higher education, offering unprecedented opportunities to enhance student learning, engagement, and achievement. By aligning extended reality experiences with specific learning outcomes, educators can create targeted and effective interventions that address individual student needs and promote mastery of essential skills and competencies. The integration of augmented reality in education has recently attracted research attention because of its ability to allow students to be immersed in realistic experiences (Alam et al., 2019). The aim is to establish the potential role that augmented and virtual reality can provide in enhancing experiential learning by providing students with practical experience in various educational fields, leveraging augmented and virtual reality technologies to simulate such learning environments (Jantjies et al., 2018). These technologies have the potential to create more engaging, effective, and equitable learning environments for students (Markowitz et al., 2018).

The incorporation of XR tools and platforms into educational settings can enable students to engage in active experimentation, problem-solving, and critical thinking, fostering a deeper understanding of concepts and promoting the development of essential skills. XR facilitates access to a vast amount of information and resources, making learning more convenient and accessible for students. One of the key benefits of integrating extended reality into outcome-based education is its ability to provide students with personalized and adaptive learning experiences. By leveraging data analytics and artificial intelligence, extended reality platforms can track student progress, identify areas of strength and weakness, and tailor instruction and feedback to meet individual learning needs. This personalized approach to learning can help students stay motivated and engaged, leading to improved learning outcomes and higher levels of achievement (Alotaibi, 2024). Moreover, the immersive nature of extended reality experiences can enhance student motivation and engagement by providing them with opportunities to explore virtual environments, interact with virtual objects, and collaborate with peers in meaningful ways (Schott & Marshall, 2020).

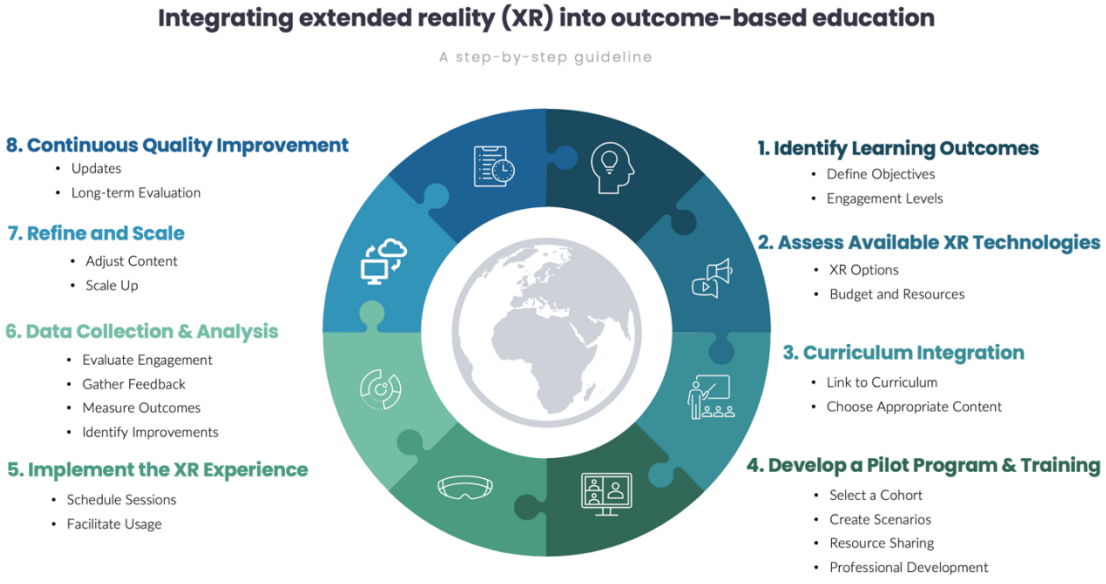

Figure 2. A step-by-step guideline on integrating extended reality into outcome-based education.

In summary, based on findings from the literature review, Figure 2 illustrates a guideline in which XR is transforming education, namely through outcome-based education. The guideline consists of eight steps on how XR technology could support OBE.

Conclusion

This literature review highlights the transformative potential of integrating extended reality (XR) into outcome-based education in higher education. Augmented and extended reality technologies have recently gained significant attention due to their ability to immerse students in realistic, interactive learning experiences. By enabling learners to apply their knowledge and skills in such immersive environments, XR can foster a deeper understanding of complex concepts and enhance the transfer of learning to real-world contexts.

In summary, incorporating extended reality into outcome-based education offers substantial opportunities to reshape higher education and better prepare students for the demands of the 21st century. Through augmented and virtual reality, learning can become more engaging, interactive, and impactful (Erwinsah et al., 2019). Moreover, XR technologies hold significant promise beyond education, particularly in mental health, where immersive virtual and augmented experiences can provide safe, controlled spaces for therapy, self-exploration, and treatment support (Kenwright, 2023).

Limitations and Future Studie

The limitation of this study is due to the limited period and scope of the literature review. An analysis of research publications from 2014 to 2024 indicates a steady rise in interest in outcome-based education and extended reality in education. The increasing number of publications reflects the growing influences of XR technologies in education. The future research should address the issues related to the adoption and effectiveness of extended reality in diverse educational contexts. By addressing these challenges, higher education institutions can unlock the full potential of extended reality to enhance student learning, engagement, and achievement in outcome-based education frameworks.

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