A Systematic Literature Review on Immersive Education

Musa Midila Ahmed

Faculty of Education, Department of Physical Sciences Education, Modibbo Adama University, Yola.

Article history

Received:
4 May 2025

Received in revised form:
10 May 2025

Accepted:
20 May 2025

Published online:
27 June 2025

*Corresponding author
ahmedmm4me@gmail.com

Abstract

Poor students' academic performance at all educational level nowadays is a significant challenge to educational stakeholders globally. A country's development is directly connected to the academic performance of its student. There are multiple factors that can influence students' academic performance, however, teachers' instructional strategy play a significant role. Immersive education is a pedagogical approach that uses virtual reality, augmented reality, mixed reality, augmented virtuality, 3D and 360 degree immersive technologies for knowledge and skill acquisition. First, the paper introduce immersive education and its categories to distinguish between these technologies. This study was guided by preferred reporting Items for systematic reviews and Meta-Analyses (PRISMA) protocol. The review protocol was designed to guide the conduct of the systematic literature review. The review method comprised of research questions, inclusion and exclusion criteria, literature search strategy, study selection process, data extraction, data synthesis and report writing. This study evaluated empirical literature published in research community on immersive education from 2020 to 2024 by systematic literature review. The findings shows that despite the novelty and importance of immersive education, studies on this innovation is on decline in recent years. Therefore, it is recommended that further research be conducted on this technologies especially on augmented virtuality, 3D and 360 degree immersive technologies to leverage on its benefits in teaching and learning in education systems. .

Keywords: *SLR, Immersive Education, Virtual Reality, Augmented Reality, Mixed Reality, Augmented Virtuality, 3D, 360º.*

1. Introduction

The use of Information and Communication Technology to deliver learning content is widely accepted as a powerful tool that transforms teacher training and professional development by provision of innovative ways to enhance educators' knowledge and pedagogical skills. These modern ICT innovations has the power to enhance the quality of teaching and learning in variety of ways. Dei [1] suggests that the 21st century instruction requires complete transformation to integrate new technological innovation that improves quality and promote accessibility of education worldwide. Therefore, it is important for the 21st century educators get access to the latest information and research findings on the emerging technologies

* *Corresponding author. ahmedmm4me@gmail.com*
DOI: 10.11113/oiji2025.13n1.324

vital for teaching professionals. According to Rezaei [2], immersive technologies open a novel development opportunities in educational multimedia systems for the modern generation. Immersive education is one of the modern emerging technologies that provides inspiring learning environment and empowers learner with robust knowledge and skills needed to excel in their chosen careers [3]. Immersive education has proven to be an effective teaching method that not only promotes learning but makes learning more engaging and enjoyable.

Immersive education is a pedagogical approach that incorporates immersive technologies to create more explorative and engaging learning experience for enhance knowledge and skills acquisition. Ali [4] posits that empirical studies should focus on harnessing the full potentials of immersive technologies especially toward human capital development. It is a learning experience that deeply engage learners in interactive technology driven environment that goes beyond the traditional classroom. Immersive education offers several benefits that enhance both learning experience and learning outcome. This teaching method leveraged on immersive technologies also refers to as extended reality to help learners gain deeper knowledge, enhance practical skills and better preparation to tackle real world challenges. Immersive education is a teaching method that uses virtual reality (VR), augmented reality (AR), mixed reality (MR), augmented virtuality (AV), three dimensional (3D) and 360 degree technologies to create highly engaging and interactive experiential learning environment. However, this technologies is distinct from the physical reality, which forms the basis for all real world experiences.

Physical reality is the actual state of natural existence that people interact with in the daily life. Multimedia instruction approach integrates audio, text, image and video of the physical realities to create an interactive and dynamic learning environment. According to Rosyara [5], use of multimedia instruction enhances learning outcome and supports learning in different dimensions. Multimedia helps to make delivery of learning content rich and useful by presentation in different formats efficiently and conveniently. In addition to promotion of learners' engagement, multimedia instruction approach also breaks the constraints of time, distance and speed in education system. In contrast with virtual reality, which offers total immersion in digital environment, physical reality is limited to natural existence, which are characterised by constraints such as accessibility challenges and risks in experiencing some activities.

VR is a computer generated environment that engage users to experience and interact with a simulated real or imagined world in a highly immersive way. VR creates the illusion of being physically present in the virtual space [6]. This makes users feel as if they are actually in the real world. Users can interact with the virtual world by movements, gestures and controller, which track their action in real time. This enables users to interact with the virtual world by manipulating objects, explore the environment and engage with elements of the simulated environment. According to Joo and Brongersma [7], the demand and adoption of virtual reality headset devices is on increase driven by numerous application ranging from social networking, games, medicine and education.

AR is a category of immersive technology that overlays digital information on the physical reality. This technology insert digital images, sounds or data onto the real world to be viewed by devices such as smartphones, tablet or specialized

glasses. In other words, augmented reality enhances the real environment by adding interactive digital elements. There are two broad categories of augmented reality; marker-based AR and markerless AR. In the marker-based AR, a physical marker such as QR code or graphic is overlaid on the real environment that triggers display of addition content. Whereas, the markerless AR does not rely on any marker but uses technologies such as digital locators and GPS to observe AR elements in the real environment. AR is a category of immersive technology that enhances the real world environment in various ways that suits different use cases and required interaction. Oleksiuk, & Oleksiuk, [8] explored the potentials of AR in teaching computer science and discovered that this technology has the potential to improve realism in research, learners' motivation and cognitive experience.

MR is an immersive technology that blends both real and digital elements to enable users interact with both physical and virtual environment simultaneously. Unlike AR, which overlays digital information on real world environment, MR merges real with virtual environment for enhanced interactive and immersive experience. In MR, the two elements coexists and interact in real time making the technology useful for designing education and training. The distinction between MR with AR and AV lie on the level of interaction and immersion offered by the technology. AR consists mostly of the real world with the virtual elements. Whereas, AV consists of virtual world with elements of real world objects. Allcoat, et al. [9] discovered that both MR and VR promotes learners engagement and learning outcomes than the conventional teaching method.

AV is a category of mixed reality in which virtual elements are superimposed onto the real world but with a heavier emphasis on the virtual environment. In AV, real world element or data are integrated into a mostly virtual environment, enhancing the users' interaction with virtual objects by incorporating some aspects of the physical world. Both AR and AV are categories of MR with different levels of integration of the real and virtual world in creating an immersive experience [10]. In AR, the primary environment is the real world, with digital elements overlaid. Whereas in AV, the primary environment is the virtual environment with some elements of the real world. Vellingiri, et. al. [11] studied the use of AV technologies in education to teach students various subjects. The author discovered that the technology afforded significant learning improvement.

Three dimensional (3D) immersive technologies refers to systems and platforms that creates an interactive 3D virtual or augmented environment. They are design to simulate the real world experience or create a completely new imaginary spaces allowing users immerse in the environment. These technologies are revolutionizing industries by enhancing virtualization in both virtual and real world settings. These technologies creates environments or experiences that simulate three-dimensional spaces, allowing users to interact with digital elements in a way that imitates the real world. It offers sense of depth and presence, making users feel as if they are physically part of the digital environment, which provides more realistic, interactive and engaging experiences across a variety of fields. Guidi and Tammaro [12] discovered that 3D technologies has significant utility in various aspects of digital libraries. The author suggest that further research is imperative on the application of 3D immersive technologies in education system.

360 degree (360º) immersive technologies refers to digital systems and platforms that create an all-encompassing environment allowing users to view or interact with content in every direction [13]. The aim of these technologies is to immerse users by replicate real world perspectives or creating fully virtual spaces, making them feel as if they are inside the scene or environment. In other word, 360º immersive technologies create fully encompassing environment where users can interact with or view content from every angle. These technologies are constantly evolving and are transforming the way user interact with digital content. It offers a range of benefits across various industries, providing unique and highly engaging experiences. These technologies offer innovative solutions to a wide range of industries, enhancing education, training and entertainment in an engaging manner. A memory assessment of 360º immersive technologies by Ventura, et. al. [14] shows that learners exposed to 360º immersive technology environment has stronger memory performance compared to those exposed to non-immersive technology environment.

The aim of immersive education is to create engaging, interactive and realistic learning environment that allow students to experience and explore content more deeply to enhance traditional learning methods. This is a novel approach to make learning more effective, engaging and accessible through innovative uses of technology. The purpose of this study is to conduct a systematic literature review (SLR) to identify research trend and categories of immersive education studied that are published from 2020 to 2024.

Objectives of the study:

i) To determine the research trend on immersive education from 2020 to 2024.

ii) To identify the types of publication made on immersive education from 2020 to 2024.

iii) To determine the level of education investigated on immersive technology from 2020 to 2024.

iv) To identify the categories of immersive education studied in the research community from 2020 to 2024.

2. Related Studies

Literature review is a critical evaluation academic literature on a specific topic placed in context to gain knowledge and understanding of the existing research and debates relevant to the area of study. This requires critical evaluation of the materials by literature analysis and meta-analysis to aggregate findings and provide a quantitative report of previous research on the topic. A literature analysis by Sandoval-Henríquez, et al. [15] focused on integration of immersive technologies in learning processes in primary education covered from 2018 to 2023. The author discovered improvement in the learning outcome of primary pupils in Asia. In addition, the recommend greater attention should be given to the use of immersive technologies in teaching and learning of science subjects. However, the author reported that little research was done on articulating and evaluating the state of existing knowledge on this subject. Similarly, a study by Baxter and Hainey [16] revealed that there are benefits of immersive education compared to the face-to-face

instruction. However, the author suggested that more empirical studies are required on application of immersive technologies in higher education.

According to Ahmed [17], systematic literature review (SLR) is a powerful tool that uses a predefined approach to achieve a thorough, robust and unbiased empirical review. An SLR by Turan and Karabey [18] on immersive technology in distance learning observed that the first study on this topic was in 2002 and the trend of research on this topic keep on increasing over the years. The author focused on academic performance and motivation in sciences and medical education. Also, Tang, et al. [19] carried out an SLR on application of immersive technology for medical practices and education. The author analysed 121 studies indexed in web-of-science from 2012 to 2022. The results shows that immersive technologies are popularly in use for training surgery and anatomy by group experimental method. These reviewed articles did not analysed empirical studies based on the categories of immersive technologies to evaluate the popularity and vitality of each extended reality. Furthermore, the last SLR on immersive technology extend to 2022 as such it is not up to date.

The uniqueness of this study lie on the need for evaluation of empirical studies conducted on the categories of immersive education to identify research gaps for areas that requires attention. Furthermore, there is the need to evaluate up to date state of research on this topic to equip researchers with current knowledge and understanding to guide educational development using modern innovations.

3. Materials and Methods

Systematic literature review usually follows review protocol to guide in selection of data that are appropriate to answer the research questions. PRISMA review protocol was adapted to provide guidance for the conduct and reporting on different categories or aspects of systematic reviews.

3.1 Review Protocol

The review protocol for this study comprised of research questions, inclusion and exclusion criteria, literature search strategy, study selection process, data extraction, quality assessment, data synthesis, and report writing.

3.1.1 Research Questions

i) What is the research trend on immersive education from 2020 to 2024?
ii) What are the types of publication made on immersive education from 2020 to 2024?.
iii) What is the level of education investigated on immersive technology from 2020 to 2024?
iv) What are the categories of immersive education studied in the research community from 2020 to 2024?

3.1.2 Inclusion and Exclusion Criteria

Inclusion Criteria

i) Primary studies was published on immersive education.
ii) Primary studies was published within the period from 2020 to 2024.

iii)Primary studies was published in English language or has written translation in English language.

Exclusion Criteria

i) All primary studies published not on immersive education.
ii) All primary studies published before 2020 and after 2024.
iii)All published primary studies written in other language and has translated English language version.

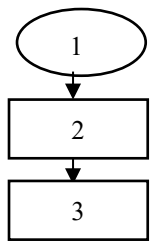
3.1.3 Literature Search Strategy

The search string for this study are:

i) ((immersive OR immersive technologies OR extended reality) AND(education OR instruction OR teaching OR learning outcome OR academic performance OR academic achievement))
ii) ((virtual reality OR virtual video OR virtual experience OR virtual environment OR virtual world) AND (education OR instruction OR teaching OR learning outcome OR academic performance OR academic achievement))
iii)((augmented reality OR augmented virtual video OR augmented virtual experience OR augmented virtual environment OR augmented virtual world) AND (education OR instruction OR teaching OR learning outcome OR academic performance OR academic achievement))
iv)((augmented virtuality OR augmented virtuality video OR augmented virtuality experience OR augmented virtuality environment OR augmented virtuality world) AND (education OR instruction OR teaching OR learning outcome OR academic performance OR academic achievement))
v) ((mixed reality OR mixed immersive video OR mixed immersive experience OR mixed immersive environment OR mixed immersive world) AND (education OR instruction OR teaching OR learning outcome OR academic performance OR academic achievement))
vi)((3D virtual reality OR 3D augmented reality OR 3D immersive experience OR 3D immersive environment OR 3D immersive world) AND (education OR instruction OR teaching OR learning outcome OR academic performance OR academic achievement))
vii) ((360º virtual reality OR 360º augmented reality OR 360º immersive experience OR 360º immersive environment OR 360º immersive world) AND (education OR instruction OR teaching OR learning outcome OR academic performance OR academic achievement))

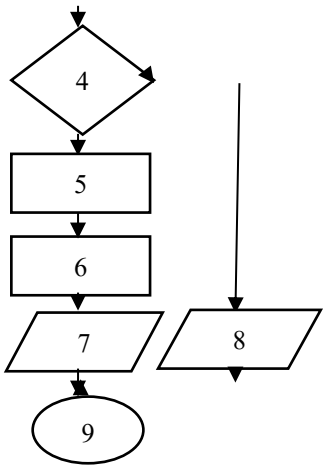
3.1.4 Study Selection Process

In compliance with the specification of the review protocol, the study selection process is depicted by the flowchart on Figure 1.



.

1. Start
2. Search by Search Strings
3. Read Publication date, Title and Abstract of



primary studies
4. Is primary studies relevant?
5. If yes, extract full text
6. Critically read full text
7. Extract relevant data
8. Exclude studies
9. Stop

Figure 1. Flowchart for selection of primary studies (Musa, et al. [20])

e) Data Extraction

The quality of primary studies was evaluated by its credibility and relevance to this study. An outline for the data extraction procedure is as follows:

i) Examine titles, keywords and abstracts of selected primary studies to remove irrelevant once.
ii) Retrieve full text of the potentially relevant primary studies for further scrutiny.
iii) Critically examine full text of the primary study for relevant data in compliance with eligibility criteria.
iv) Make final decision on the primary study and extract relevant data required for this study.

f) Quality Assessment

All journal articles, full proceedings papers, and books published from 2020 to 2024 are searched in the research community. Subsequent to application of the inclusion and exclusion criteria to remove all irrelevant materials, further quality assessment was carried to ensure duplicates were removed and materials collected are relevant in answering the research questions. First, ensure that primary studies are published within 2020 to 2024. Second, ensure that primary studies are published on immersive education. Finally, ensure that primary studies has English language version.

g) Data Synthesis

This section present activities in the articulation and summarizing all relevant primary studies collected from the research community in the reviewed period. In line with the research questions of this study, the data synthesis is divided into three groups. First, classification of primary studies according to the publication year. Second, sorting primary studies based the on the type of publication. Finally, classification of primary studies according to the categories of immersive education covered. Then, meta-analysis techniques was applied for statistical evaluation of the results obtained for each research question.

h) Report Writing

Report writing is a means of presenting information on research findings to audience in a structured and organized manner. It is a way of communicating facts, findings and recommendations in various formats, complexities depending on goal and audience. The results section of this study presents data and information obtained in a logical and coherent manner. It is organized according to the research questions in tables, graph and charts to illustrate the trends and key points.

4. Results and Discussions

The results of this study is present according to the research question as follow.

RQ1. What is the research trend on immersive education from 2020 to 2024?

Overall 207 primary studies scaled through the review protocol as shown in Figure 2. First, 53 studies was identified in 2020 published on immersive education. The number of primary studies dropped slightly to 46 in 2021. It then rise to its maximum 69 in 2022 and dropped to 39 in 2023. It finally reduced to the lowest number 8 in 2024. The record shows that the highest number of publication was recorded in 2022 and the lowest was in 2024. The results shows the there is decline in research on immersive technology from 2022 to date.

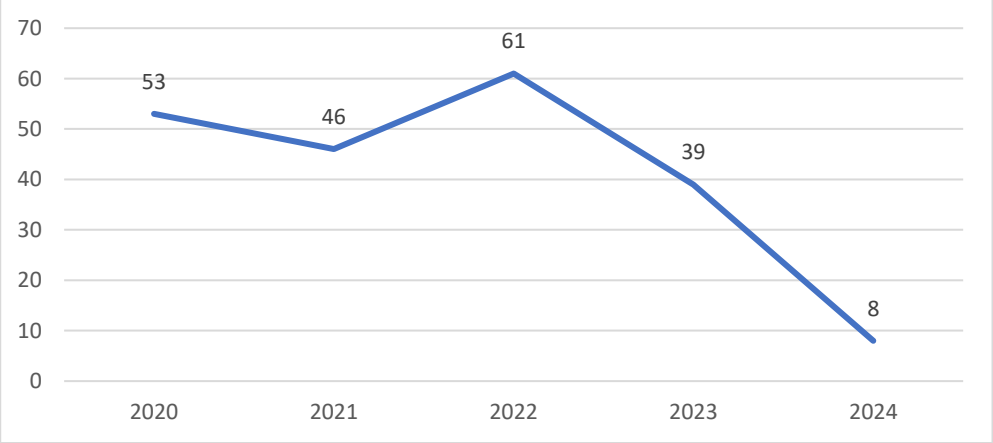


Figure 2. Yearly Publication on Immersive Education

RQ2. What are the types of publication made on immersive education from 2020 to 2024?.

The pie chart on Figure 3 shows the number of primary studies recorded for the three popular type of publications. The chart shows journals is the most popular type of publication on immersive education in the reviewed period with 169 articles. This is followed by conference proceedings with 26 publication and the lowest type of publication is books and book chapters with only 12 articles. The results shows that journal is by far the most popular source of empirical studies on immersive technology.

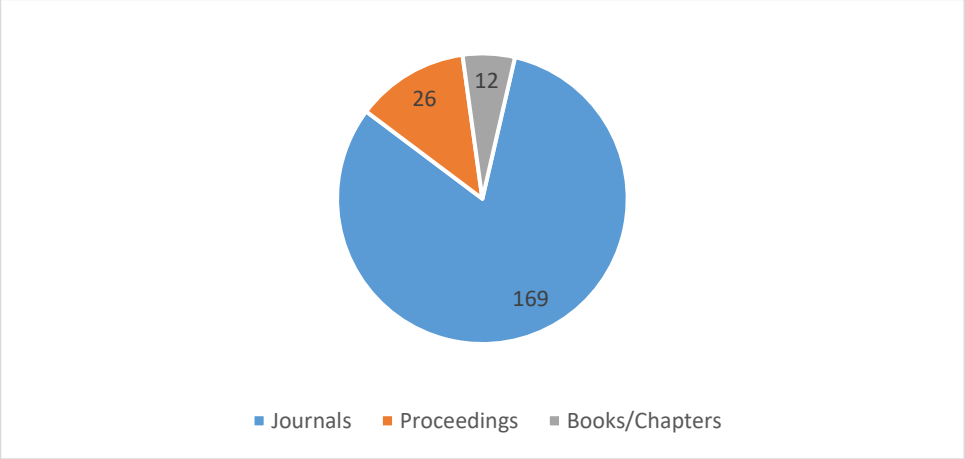


Figure 3. Type of Publications on Immersive Education

RQ3. What is the level of education investigated on immersive technology from 2020 to 2024?

The histogram on Figure 4 presents the educational level investigated in the reviewed period. Out of the total 207 primary studies identified in this study, 61 studies was conducted on education in general. Most researchers carried out their studies in higher education with a record 98 studies. Primary and secondary education recorded 18 and 27 studies respectively. The least educational level that was investigated using immersive technologies is pre-primary education with only 3 studies.

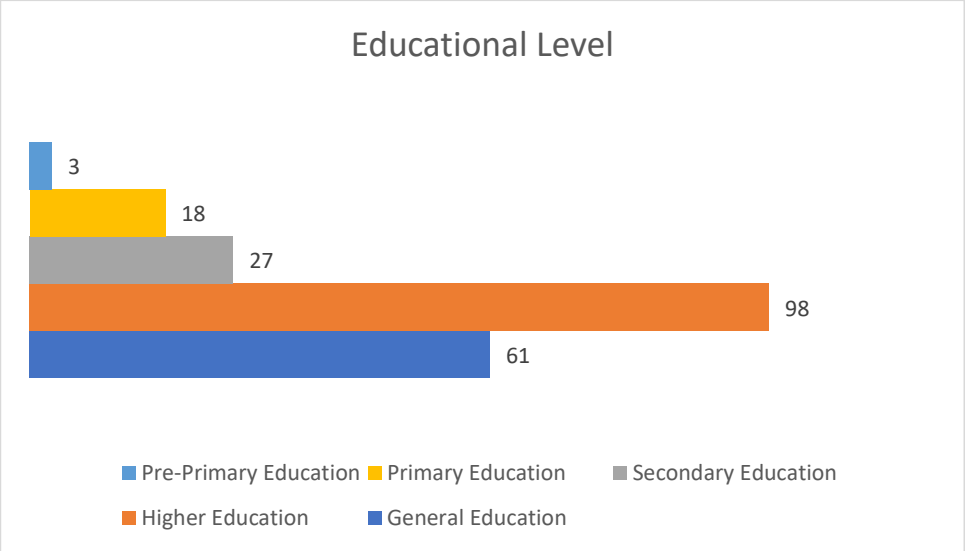


Figure 4. Educational Level of Publication on Immersive Education

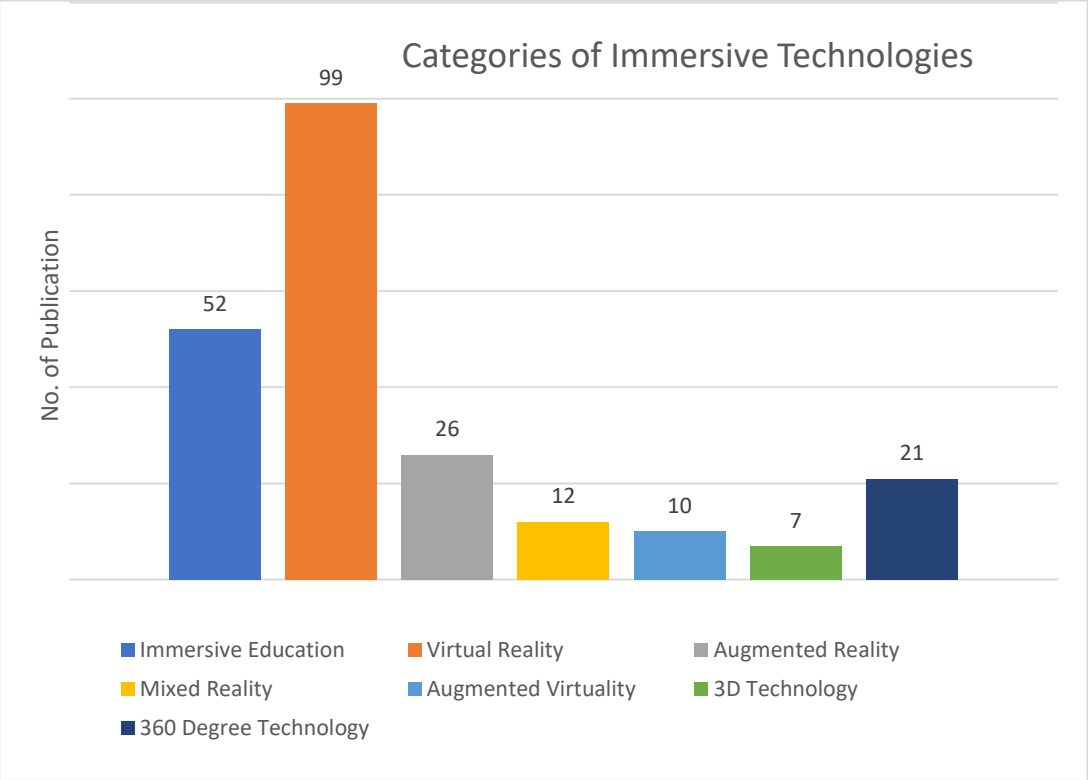
RQ4. What are the categories of immersive education studied in the research community from 2020 to 2024?

The evaluation of the categories of immersive education investigated in the reviewed period is summarized in Figure 5. The bar chart shows that most

researchers carried out their studies on virtual reality with 99 records. Whereas, the least investigated category of immersive education is 3D technology. 52 studies was on immersive education in general. 26 author focused on augmented reality, 12 on mixed reality, 10 on augmented virtuality and 21 studies was conducted on 360º technologies.

Figure 5. Categories of Immersive education Published

5. Conclusion



In conclusion, despite the importance of immersive technologies in improving learning outcomes and learners' engagement, studies have shown that there is a decline in research on this novel instructional innovation. It recommended to intensify research on immersive education, especially in the areas that less attention in the reviewed period such as augmented virtuallity, 3D immersive technologies and 260 degree immersive technologies' application to education.

Acknowledgments

The support and encouragement of the council and management of Modibbo Adama University Yola, Nigeria is acknowledged.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this paper.

References

[1] Dei, P. R. , Role of Media and Technology in the digital Era of 21st Century Education. International Journal of Scientific Research in Engineering and Management,2024. 8(3), 1-7.

[2] Rezaei, A. R. Applications of immersive technologies in education: A systematic literature review. *Advances in Online Education: A Peer-Reviewed Journal*, 2024. *2*(3), 232-251.

[3] Baxter, G., & Hainey, T.. Using immersive technologies to enhance the student learning experience. *Interactive Technology and Smart Education*, 2024, *21*(3), 403-425.

[4] Ali, S. The effectiveness of immersive technologies for future professional education. Futurity Education, 2022. 2(2), 14-22.

[5] Rosyara, AMultimedia approaches in educational technology instruction: assessing effectiveness and impact. International Journal of Pedagogics, . 2024. 4(07), 8-14.

[6] Grabarczyk, P. What is Real in Virtual Reality?. *Roczniki Filozoficzne/Annales de Philosophie/Annals of Philosophy*, 2024. *72*(1), 79-98.

[7] Joo, W. & Brongersma, M. L. Creating the Ultimate Virtual Reality Display. Science, 2022. 377(6613), 1376-1378.

[8] Oleksiuk, V., & Oleksiuk, O. Exploring the potential of augmented reality for teaching school computer science. In Proceedings of the 3rd International Workshop on Augmented Reality in Education (No. 2731). CEUR Workshop Proceedings. 2020.

[9] Allcoat, D., Hatchard, T., Azmat, F., Stansfield, K., Watson, D., & von Mühlenen, A. Education in the digital age: Learning experience in virtual and mixed realities. Journal of Educational Computing Research, . 2021. 59(5), 795-816.

[10] Bhowmik, A. K. Virtual and augmented reality: Human sensory-perceptual requirements and trends for immersive spatial computing experiences. *Journal of the Society for Information Display*, 2024. *32*(8), 605-646.

[11] Vellingiri, S., McMahan, R. P., Johnson, V., & Prabhakaran, B. An augmented virtuality system facilitating learning through nature walk. Multimedia Tools and Applications, 2023. 82(1), 1553-1564.

[12] Guidi, G., & Tammaro, A. M. Embracing 3D and immersive technologies in digital libraries: interview with Gabriele Guidi. Digital Library Perspectives, 2024, 40(1), 148-153.

[13] Reyes, M. C. Towards Immersography: Considerations for an Integrated Understanding of Immersive Narrative Experiences. In *Screenwriting for Virtual Reality: Story, Space and Experience,* 2024. (pp. 101-125). Cham: Springer International Publishing.

[14] Ventura, S., Brivio, E., Riva, G., & Baños, R. M. Immersive versus non-immersive experience: Exploring the feasibility of memory assessment through 360 technology. Frontiers in psychology, . 2019. 10, 2509.

[15] Sandoval-Henríquez, F. J., Sáez-Delgado, F., & Badilla-Quintana, M. G. (2024). Systematic review on the integration of immersive technologies to improve learning in primary education. *Journal of Computers in Education*, 1-26.

[16] Baxter, G., & Hainey, T. Using immersive technologies to enhance the student learning experience. Interactive Technology and Smart Education, 2024. 21(3), 403-425.

[17] Ahmed, M. M. SOSE-Based E-Government Systems: A Systematic Literature Review. International Journal of Management, Technology and Social Sciences (IJMTS), . 2016. 6(2), 282-295.

[18] Turan, Z., & Karabey, S. C. The use of immersive technologies in distance education: A systematic review. Education and Information Technologies, 2023. 28(12), 16041-16064.

[19] Tang, Y. M., Chau, K. Y., Kwok, A. P. K., Zhu, T., & Ma, X. A systematic review of immersive technology applications for medical practice and education-trends, application areas, recipients, teaching contents, evaluation methods, and performance. Educational Research Review, 2022. 35{1}, 1-22.

[20] Musa, A. A., Mohammed, F. J., Ugwuadu, R. O. & Ahmed, M. M.). Effect of computer-based simulation on learning outcome: A systematic literature review. Open International Journal of Informatics, 2022 10(1), 84-96.