

Using Metaverse-based Learning as a Strategy to Improve Higher Education: A Systematic Review (2019-2023)

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Abstract

With the leap of modern technology, metaverse-based learning is booming. It breaks through the limitations of space and time and promotes the sharing of high-quality educational resources. Among them, user attitudes of using metaverse-based learning technology in higher education is one of the most important contents. Because students of every major are involved in improving their professional ability, and not everyone can experience a professional environment, metaverse-based learning plays an important role in higher education and professional training. Improving teaching and learning quality of higher education institutions in the form of metaverse-based learning is one of the crucial factors to ensure its sustainable development. However, the studies on metaverse-based learning are insufficient though it has great significance in the higher education area. By using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method, this study takes past articles as the research objects, and one main database named Scopus with one supporting database named Web of Science (WoS) was used. A total of 12 articles were selected and 3 themes emerged from it, namely learning acceptance construction, learning environment construction, and learning assessment construction. Last, some points were implemented in the study which can be the keystone of future research.

Keywords: Metaverse-Based Learning, Virtual Reality, Strategy, Higher Education, Higher Learning

Introduction

In the field of education, metaverse technology is of great significance (Ren et al., 2022). It can allow students to experience a virtual classroom with real classroom elements, and this is more engaging than simple online learning (Tlili et al., 2022), such as the use of games and applications in mobile learning field (Rafiq et al., 2021).

With the leap of modern information technology and its application in the field of higher education, online education has attracted more and more attention all over the world. As one of the forms, metaverse-based learning is a teaching mode which can unlock a variety of fantastic learning experiences for learners (Zhang et al., 2022) realized by using network technology and multimedia technology. It breaks through the limitations of space and time and enables learners to flexibly make learning plans according to their own conditions, promoting educational quality. It is the time for higher education to adjust the learning mode in the field of metaverse in time with the development of science and technology.

The problem in using metaverse-based learning technology in higher education is that the educators and students are used to traditional lectures, not used to learning the latest metaverse-based learning technology in time. The most direct problem is that students do not have the ability to work efficiently, so many of them still need metaverse technical skills training after graduation. Besides, educators also need the training because of the development of video courses, the construction of resource networks, and the sharing of high-quality educational resources around the world have shown great advantages at the stage of higher education, such as learning management systems, social media, simulation, and so on (Tsz & Ng, n.d.). It is also very necessary and important to evaluate metaverse-based learning technology.

No matter how the learning mode is reformed or how the learning content is, the outcome of learning is one of the most important factors that affect the sustainable development of higher education. However, from the existing research, we can find that there are some problems in using metaverse-based learning in higher education, such as weak awareness of metaverse technology, lack of effective Learning environment construction and learning assessment construction. Thus, this study is to review the latest studies in metaverse-based learning in higher education with this research question:

RQ: What are the metaverse-based learning strategies used in higher education to improve the Student Learning Outcomes (SLOs)?

There are several limitations to past studies. Some of the studies are relatively simple. Data to support the full breadth of the model and its initiatives will not be available for several years given the 4-year cycle of the undergraduate programs (Southworth et al., 2023). Besides, lack of depth and breadth still exists (Southworth et al., 2023).

This study is organized by the research question mentioned above: What are the metaverse-based learning strategies used in higher education to ensure the SLOs? This study aims to review past articles to gain more critical understanding of the metaverse-based learning techniques used in higher education institutions. What's more, this study also points out the challenges encountered by the students and educators in the metaverse lectures.

This study makes a crucial contribution to metaverse-based learning technologies. It also enables people to get knowledge of recent metaverse-based learning applications. Moreover, it points out important topics that should be researched in the future.

Methodology

This part discusses how to use the method named PRISMA to select suitable studies related to the metaverse-based learning strategies used in higher education institutions. There are some steps of PRISMA called identification, screening, and included. Also, it used two databases named Scopus and WoS to select articles.

Prisma

PRISMA is commonly used in the education field (Ramalingam et al., 2022). This method can be used to identify articles (Page et al., 2021) related to metaverse-based education in higher education institutions.

Resources

The research relies on one main database named Scopus and one supporting database named WoS. They all cover a wide range of subject areas, article type, languages, research years and keywords which can help to refine the search results to select suitable articles for the study.

Selecting Steps

PRISMA has steps, namely identification, screening, and included (Rafiq et al., 2021), as shown in Figure 1.

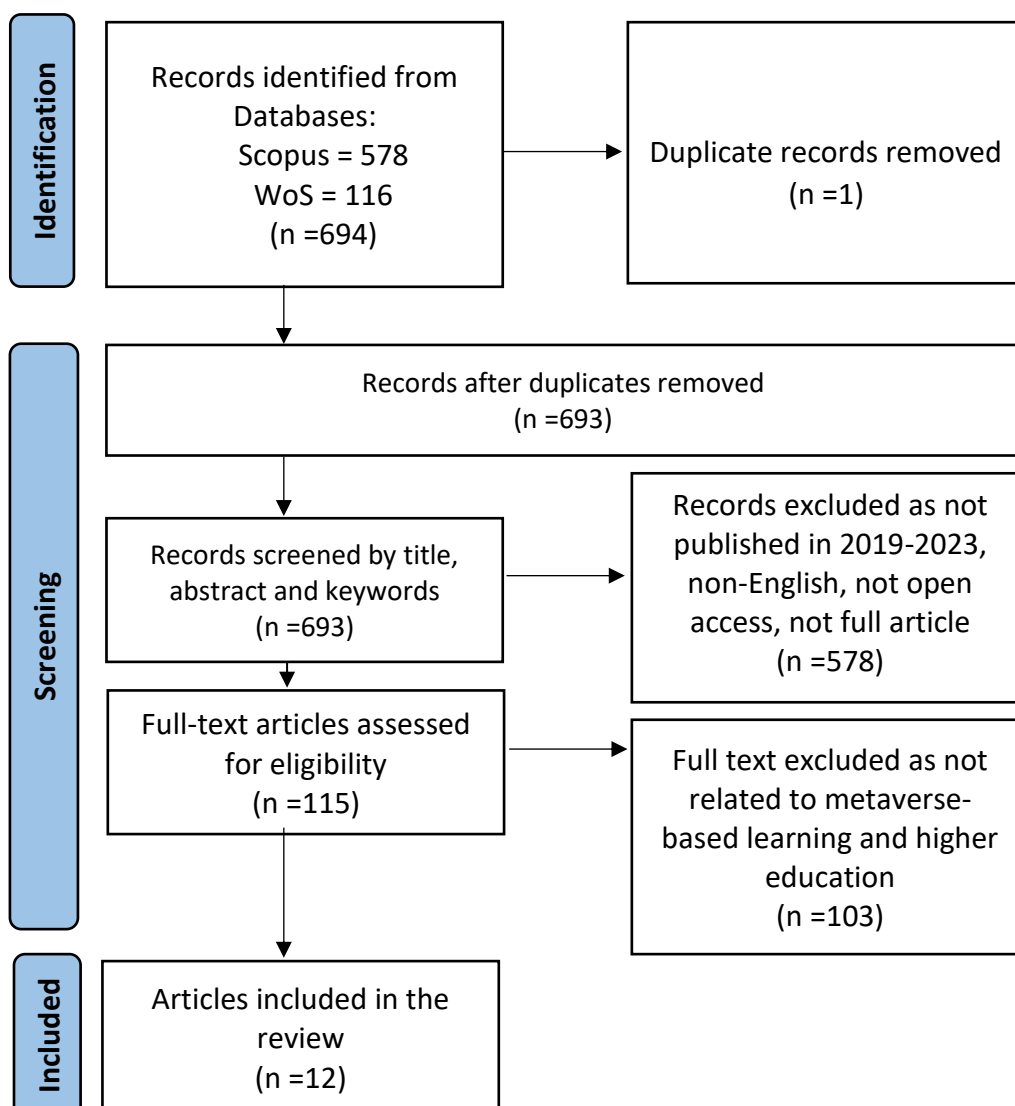


Figure 1. PRISMA systematic review.

Identification

The first step is identification. It finds and enriches the keywords of the research title, using Boolean operator or phrase searching or truncation to find similar or related terms, variations, and synonyms of the keywords for the study title, which are metaverse-based learning, strategy, and higher education in this study to select suitable articles to be analyzed in this study. Then, the study can use the keywords and synonyms as search string to input to search articles in two databases: Scopus and WoS, using different field codes. The search strings are shown in Table 1. A total of 694 articles were selected.

Table 1

The search string for identification.

Database	Search String
Scopus	TITLE-ABS-KEY ((“metaverse-based learning *” OR “metaverse education *” OR “virtual reality *”) AND (“strategy *” OR “technique *” OR “method *”) AND (“higher education *” OR “higher learning *” OR “tertiary education *”))
WoS	TS = ((“metaverse-based learning *” OR “metaverse education *” OR “virtual reality *”) AND (“strategy *” OR “technique *” OR “method *”) AND (“higher education *” OR “higher learning *” OR “tertiary education *”))

*: Search String.

Screening

The second step is screening. 1 duplicate articles in two databases were deleted by the researcher. Then, using inclusion criteria to analyze the 693 articles to do the screening based on title, abstract, and keywords, related to metaverse-based learning and higher education. 578 articles were excluded, and 115 articles were screened by criteria in Table 2.

After thoroughly selecting based on Table 2, 103 articles that do not meet the select criteria were excluded, remaining 12 articles to analyze.

Table 2

The selection criteria of the articles.

Inclusion Criteria	Exclusion Criteria
Articles published between 2019 and 2023	Articles published before 2019
Full articles from journals	Proceedings of conference, review articles, books, reports
Articles in English	Articles not in English
About metaverse-based learning and higher education	Not about metaverse-based learning and higher education

Included

Book, book chapter, mini review, systematic review, conference paper, conference review, conference abstract, encyclopedia, discussion, editorial, non-English, and articles published before 2019, and unopened access articles were excluded.

The 12 articles included for this systematic review are shown in Table 3.

Results

Characteristic of the Articles

Selected articles were on different study fields, angles, applications, and nationalities of research targets, using various metaverse technologies. Besides, the characteristic of the 12 articles was summarized as Table 3. There are three themes of the application of metaverse technology that were found, called learning acceptance construction, learning environment construction, and learning assessment construction.

Table 3

Characteristics of the articles.

Theme	Metavers e Technology Type	Study Field	Study Angle	Application	Research Targets	Researcher
	Metavers e-based learning platform	Metaver se technolo gy in educatio n	Prediction	Students' intention	574 students from private and public universities in Jordan	Al-Adwan et al., 2023
Learning Acceptan ce Construct ion	Augmente d Reality (AR)	AR in classroo ms	Candidates ' opinions	Students' Perceptions	82 candidate teachers in Departmen -t of Computer Education and Instruction Sural, 2018 al Technology , Faculty of Education in Turkey	
	Immersive Virtual Reality (IVR)	Educatio nal mini game	Learner's computati onal thinking	Students' Perceptions	49 undergrad uate students who played an IVR game- based application	Agbo et al., 2023

					(iThinkSmart) including mini games in Nigeria	
Virtual reality (VR) headset	Two-dimensional (2D) and 360° videos	Students' experience	Students' responses		100 responses in a higher education setting from Finland	Alamäki et al., 2021
Extended reality (XR)	XR in teaching	Technology adoption	End-user acceptability		The University of Newcastle Human Research Ethics Committee in Australia	Kluge et al., 2022
Three-Dimensional Virtual Worlds (3DVW)	3DVW	The impact of factors, effects investigation	User acceptance		135 undergraduate students, who were enrolled in a first-year elective course in Australia	Ghanbarzadeh & Ghapanchi, 2019
Virtual environments	E-portfolios	Understand the emotions	Students' emotions		358 students majoring in Primary Education, from the University of Granada, Spain	Crisol Moya et al., 2021
XR, VR, AR	E-Learning facility	Impact and influence	Respondents' views		1032 students from Serbia, Romania, and	Bucea-Manea-

					Hungary, from five public and private universities	Toniş et al., 2020
Learning Environment Construction	XR teaching application	Pilot project	Comparison of applications	Selection, development, implementation, end-user feedback	Teaching staff who were directly involved in the STEP1 pilot projects and students registered the courses using the developed XR tools from The University of Newcastle, Australia	Kluge et al., 2023
	Virtual game	Kahoot, Quizlet	Future teachers	State of gamification in educational process	Future research and teaching staff of higher education institutions from European Union	Oksana et al., 2022
	Artificial Intelligence	AI across curriculum	Model developing	Course assessment	Infusing AI across the curriculum and creating opportunities for students engagement within identified	Southworth et al., 2023

<p>Learning Assessment Construction</p>	<p>e (AI) literacy</p>	<p>areas of AI literacy regardless of student discipline in USA</p>			
<p>IVR application</p>	<p>Foreign language learning</p>	<p>Comparison of IVR to mobile</p>	<p>Educational value</p>	<p>40 Greek-speaking undergraduate students with little or no knowledge of the Italian language in Greece</p>	<p>Nicolaidou et al., 2023</p>

Main Findings

Ensuring SLOs is deemed crucial for higher education institutions. Nevertheless, it has become an issue for students and teachers as many of them are still facing some problems in using metaverse-based learning techniques like AR, VR, XR, and so on.

Previous studies reveal that the uneducated metaverse technology capability of students and educators is remarkable because of the traditional learning experience. Also, past literature highlights that metaverse learning environment construction is very challenging for existing higher education institutions. Moreover, the findings of past studies reveal that the students have deficient immersion and engagement in traditional learning activities.

The findings from past articles depict that higher education students and teachers encounter challenges to improve learning outcomes when they are having lectures or learning activities. These problems could be solved by using metaverse-based learning technologies.

This part explains the 3 themes of metaverse-based learning strategies that can be used in lectures and activities to solve the problems faced by students and teachers. The three themes were learning acceptance construction, learning environment construction, and learning assessment construction.

Learning Acceptance Construction

Learning acceptance construction is a theme that appeared based on this study. Based on the process of reviewing 12 articles, 7 articles discuss learning acceptance construction creation. SLOs of the higher education institutions can be enhanced by using metaverse-based learning technology to raise learning acceptance and willingness.

The emotional dimension has been shown to be a very important factor in teaching and learning processes (Crisol Moya et al., 2021) because it may influence students' acceptance

and academic performance to learning content and eventually influence learning outcomes through its ease, efficacy, usefulness, enjoyment, and innovativeness. Optimism perception of the willingness to adopt metaverse technology may help to break existing challenges of traditional learning model, decline learning anxiety (John & Yunus, 2021) and foster higher acceptance of learners.

The findings of review show that metaverse technology could make research targets excited and increase their learning willingness and the increasing of learning willingness may lead to more learning outcomes. According to past study, 360° videos and VR technology enhance the social sharing intention of learners, having increased positive effect on their behavioral intentions of study. Besides, XR can provide learning in a comfortable style which makes participants curious, giving positive influence on students learning acceptance because of its function to improve interactivity, enthusiasm, and motivation especially for younger students. Besides, a positive connection has been proved between students' motivation and e-portfolios when they work with it (Crisol Moya et al., 2021). It makes students feel less pressure and negative emotions, contributing to learning acceptance. Moreover, the use of the 3DVWs technology has a crucial influence on students' immersion, engagement, learning outcomes, retention ability, and graduate outcome of higher education institutions (Ghanbarzadeh & Ghapanchi, 2019).

These metaverse technologies have the possibility to be implemented and received in remote learning programs in the higher education institutions and will lead to positive learning outcomes for learners.

Learning Environment Construction

Learning environment construction can also be applied to improve higher education. Based on 12 articles, 2 articles discuss learning environment construction creation. SLOs of the higher education institutions can be generated by metaverse-based learning technology to create an effective learning environment construction and innovative learning pedagogy (Santhanasamy & Yunus, 2022).

Learning environment connects to learners' interactivity, engagement, feedback, impression, and immersion, and then immersion and visual attractiveness of metaverse technology may impact participants' reflective comprehension, cognition, computational thinking skills, and critical thinking skills through its impact on learners' satisfaction.

XR teaching applications can create a suitable distance learning virtual environment by its effective chances for experimentation and simulation, clear guidelines for suitable teaching content, a pre-defined framework for hardware distribution and guide staff throughout the entire process of its adoption, development, and implementation (Kluge et al., 2023). These factors may assist learners in a great environment in university education. What's more, VR activates students with situational awareness through its media richness. Besides, teaching staff of higher education institutions also utilize gamification like Quizlet and Kahoot! as effective tools or platforms in assisting and enhancing students' self-learning skills and retention quickly in the lecture by creating different games related to learning content and building an effective atmosphere or environment for educators. According to past study, game-based learning in higher education leads to students' increasing adaptive skills to adapt

the develop trend of society environment, which game-based approach is becoming more and more important in workplaces and educational institutions in the future to promote stress-free environment (Rajendran & Md Yunus, 2021).

Learning Assessment Construction

Learning assessment construction is another theme that appeared from this research. 2 articles of 12 articles discuss how to improve higher education from this theme. SLOs of the higher education institutions can be assessed and valued by metaverse-based learning technology.

Learning assessment is important for students' future development since students may use the content, they learn to complete their work. Metaverse technology can enhance workforce development and career readiness of students (Southworth et al., 2023).

AI is a tool and technique which makes learning assessment easier. They specify different aspects of data science including "the availability to understand data, making good judgements about and good decisions with data, and using data analysis tools responsibly and effectively" (Southworth et al., 2023). However, existing institutions of higher education currently have limitations of campus-wide AI initiatives (Southworth et al., 2023). AI is a comprehensive set of skills, and it should be built into the fundamental curriculum assessment of a university. Also, IVR applications on foreign language learning can improve students' engagement, engrossment, and immersion of VR participants (Nicolaidou et al., 2023), which proved their educational value. An article indicates that IVR applications are helpful to assist vocabulary learning in foreign languages, proving the possible educational value of IVR applications. It could be applied in lectures to improve students' motivation, immersion, engagement, and interest in their learning contents.

Discussion

The findings of this study point out the metaverse learning methods which open new perspectives for higher education (Salmerón-Manzano & Manzano-Agugliaro, 2018). The strategies were learning acceptance construction, learning environment construction, and learning assessment construction. Findings showed that they could be used in improving learners' self-regulation, immersion, motivation, engagement, and are also helpful for educators and higher education institutions in theory and practice (Deroncele-Acosta et al., 2023). These skills may be helpful to the academic, scientific, and institutional discussion around the improvement of decision making based on the available information (González-Zamar & Abad-Segura, 2020).

Firstly, learning acceptance construction is a concerning factor that can influence higher education improvement. They could be applied in lessons and activities to cultivate critical thinking, providing focus on tasks, and encouraging self-learning (Tsekhmister, n.d.). The selected articles showed that both students and staff expressed an optimistic attitude toward metaverse technology, such as the adoption of VR technology which considered activating students with situational awareness. The willingness of institutions will become the key to the application of these technologies when they become more important pathways for higher education lectures in the future. Educators also need to change their cultural mindset and pay close attention to these technologies because they may positively affect students'

reflective thinking and cognition, such as feedback, immersion, and interaction (Bucea-Manea-Țoniș et al., 2020).

Researchers should pay more attention to their perceived enjoyment and perceived usefulness (Al-Adwan et al., 2023) when they use metaverse technologies. Also, the results highlighted that metaverse researchers should pay attention to creating mechanisms to lower the privacy and security risks to increase their acceptance, particularly from developing countries.

Furthermore, learning environment construction is also vital for higher education learners, as they can have immersive learning experience. Metaverse-based learning technologies are immensely helpful for the students since they can use these methods to define their own learning goals.

Educators should focus on the relationship of the capacities of XR and educators' teaching needs and enrich the background experience. So, they can use it as a link to traditional teaching mode (Kluge et al., 2023). Also, higher education institutions should develop to assist and make sure of the formation of game-based learning skills in the educational activities. It is a method that leads to suitable assessment and students' learning improvement (Oksana et al., 2022). These educational games are based on a learning assistant platform, which can create different games and stimulate learning to make it more effective by showing learners the contents which they need to learn and making it accessible.

Besides, learning assessment construction using AI and IVR is also indispensable.

By using AI technology, new AI content development in courses can be realized with the help of organizations like The AI² Center, which is a central organizational point at The University of Florida for AI-related academic programs (Southworth et al., 2023). Organizations like this can lead to curriculum development with assistance from the colleges and course literacy identification and supervision sustainingly. Also, IVR applications on foreign language learning can improve students' immersion, engagement, engrossment, and of VR participants, which proved their educational value. It implies that higher education institutions need to make immersion a vital factor to assess learning outcomes. Students showed an emotional link and great attention to the application. Financial investment in IVR applications has proved to provide immersive experience for students and educators can utilize this factor to assess a course to judge if the students may have effective learning.

However, metaverse technologies are not widely adopted or sustainably supported in higher education institutions. Effective metaverse-based learning needs collaboration from learners, and institutions which is significant to solve the problems encountered by them.

Despite the positive characteristics of metaverse-based learning, not only are learners required to know basic concepts, knowledge, and new skills of metaverse technologies to use in their lectures and future workplace, but also educators and relevant staff need to become AI specialists to assist faculty build and students in using the latest technologies. This is why it is very significant to have collaborations between the learners and higher education institutions. Good collaborations between the learners and institutions foster the

improvement of education qualifications by reducing the challenges. They have great potential to finally achieve sustainable education.

Conclusions

In summary, this research has analyzed studies related to metaverse-based learning in higher education. The paper aims to review the latest utilization of metaverse technology for higher education lectures. Three databases have been used and 12 articles were selected according to PRISMA. The main result emphasized three strategies in metaverse-based learning in higher education. They are learning acceptance construction, learning environment construction, and learning assessment construction.

This study offers a few significant contributions concerning metaverse-based learning technologies. Firstly, based on the results mentioned above, it may contribute to enabling learners and educators to get knowledge of recent metaverse-based learning applications and use these theoretical guidelines to select adaptive metaverse educational tools to use in learning and teaching activities in higher education context. Additionally, different metaverse learning methods may make educators utilize these technologies as a kind of support on education activities. Moreover, it points out important topics that should be researched in the future. Future researchers could pay attention to learners' emotions and the materials which can be used in a metaverse-based learning environment.

This research has a few limitations. First, it focuses on higher education but not a specific course. Future studies could try to focus on a subject to examine the strategies used to improve higher education learning outcomes. Second, this review was organized with articles from databases named Scopus and WoS. Thus, the findings may differ from the current ones where researchers use other databases like Google Scholar, Science Direct, and so on.

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