

# *Application of Metaverse in Health Professions Education: A Scoping Review*

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**Abstract:** Attention to the metaverse has been increasing worldwide as the immersive virtual environment provides opportunities for simulation experiences. The metaverse has high acceptance in the nursing field, especially among nursing students, for applications such as theoretical courses and skill training. Therefore, we aim to explore the application of the metaverse in health professions education by searching published studies. Our review searched for published articles about the metaverse in three databases (Web of Science, PubMed, and Scopus) and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines using the PRISMA-ScR checklist. The final review comprised 15 articles from different countries published between 2014 and 2024, most of which indicate that the metaverse could increase knowledge, self-confidence, and performance in health professions students. Our findings provide insight into the application of the metaverse in health professions education. This study will enable health professions to be better equipped to face future challenges.

## 1. Introduction

The term “metaverse” was originated from science fiction novel *Snow Crash* by Neal Stephenson in 1992, Compared with other mature technologies in education, the metaverse is still in its early stages<sup>[1]</sup>. Due to the great impact of COVID-19 on medical care, healthcare providers are inclined to seek more solutions for managing patients outside hospitals and promoting immersive learning and skills training. As a result, it is essential to establish a new world where health professions can make immersive training in any clinic scene that could be duplicated even in dangerous situations. Metaverse is the convergence of enhanced physical reality and physically persistent virtual space rather than a single entity. It provides immersive, collaborative scenes where users conduct social, economic, and cultural activities and interact with others through four types: augmented reality (AR), virtual reality (VR), lifelogging, and mirror worlds<sup>[2]</sup>. Tzu<sup>[1]</sup> reported that

many industries, including healthcare, have adapted to the metaverse, with technologies such as artificial intelligence (AI), machine learning, and big data<sup>[3]</sup>. At the same time, metaverse has been confirmed useful in health education, especially during the past few years<sup>[4]</sup>. These emerging technologies provide brilliant insights for immersive learning and training, enhancing the efficiency of nursing education<sup>[5]</sup>.

Application of chatbots and VR for learning and training is still a relatively new direction in health professions education<sup>[6]</sup>, some studies have explored the use of virtual patients to strengthen communication and collaboration abilities of nursing students<sup>[6,7]</sup>. Quqandi reported that the use of advanced technology has improved independent learning skills of students, enabled students to be immersed in a realistic experience<sup>[7]</sup>. Metaverse can help nurses build abilities and confidence in managing remote patient care by providing interactive simulations, which could increase nurses' collaboration and decision-making capabilities<sup>[5]</sup>. Research indicates that experiential learning is more effective and interesting than the traditional education model<sup>[4]</sup>, curriculum design that benefits from metaverse technology could construct realistic atmosphere for students which could enhance theoretical knowledge, skills, involvement, enthusiasm and creativity. In fact, many subjects have adapted to the metaverse, such as palliative care<sup>[8]</sup>, emergency medicine<sup>[11]</sup>, human anatomy<sup>[9]</sup> by these technologies have realized interprofessional collaboration, professional knowledge delivery and operation training. The metaverse has made remarkable advancements in clinical education in recent years.

The metaverse has been involved in health professions education and created a lot of emerging education forms and new-typed methods, To record and check developing trend of the metaverse and monitor its potential application scope in the future, we propose to appraise its application in the field of health professions education. To ensure searching and acquiring as many as possible relating to the topic of metaverse. we put forward the following research questions based on the framework of Arksey and O'Malley<sup>[10]</sup>: (1) What techniques of metaverse are used in health professions education? (2) How is the curriculum adapted to metaverse? (3) What are the current conditions for using metaverse techniques in health professions education? (4) What are the potential development of metaverse in health professions education?

## 2. Materials and Methods

The search process followed the Preferred Reporting for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews guidelines with the PRISMA-ScR checklist<sup>[11]</sup>. The registration number of the review protocol is <https://doi.org/10.17605/OSF.IO/E8V24> in OSF.

### 2.1 Eligibility Criteria

Studies meeting the following criteria were included in this review: (1) participants were health professions students, (2) The metaverse in health professions education was reviewed, (3) sufficient outcomes were provided. Studies were excluded if they did not reported sufficient students' data to determine the effect of the intervention, or if they reported on metaverse in the context of application not directly related to health professions education.

### 2.2 Information Sources and Search Strategy

A preliminary search has conducted in the Web of Science, Pubmed, Scopus between 2014 and on July 16, 2024. The Search Strategy are (metaverse[Title/Abstract]) OR (Augmented Reality[MeSH Terms]) OR (Virtual Reality[MeSH Terms]) OR (Mixed Reality[MeSH Terms]) OR (virtual technology[Title/Abstract]) OR (avatars[MeSH Terms]) OR (Immersive

simulation[Title/Abstract])) OR (Augmented Realities[Title/Abstract]))OR(virtual realities[Title/Abstract]))OR(simulated reality[Title/Abstract])) OR (Mixed Realities[Title/Abstract]))OR(avatar[Title/Abstract]) AND (Teaching[MeSH Terms]) OR (Education[MeSH Terms]))OR(Nursing Education[MeSH Terms])) OR (Learning[MeSH Terms])) OR (curriculum[MeSH Terms])) OR (course[Title/Abstract])) OR (nursing[MeSH Terms])) AND english[LA].

## 2.3 Selection of Sources

A scoping review was considered to conduct in-depth analysis about metaverse's current and future trends and application in health professions education. To ensure that a substantial range of literature was captured relating to the topic of interest, we put forward a few research questions according to Arksey and O'Malley's<sup>[10]</sup> framework to guide the search:(1)What techniques of metaverse are used in health professions education?(2)How curriculum adapted to metaverse?(3)What are the current conditions for using metaverse techniques in health professions education? (4)What is the potential development of metaverse in health professions education?

## 2.4 Data Charting

Two master's degree holders examined the retrieved articles independently according to the PRISMA-ScR<sup>[11]</sup> statement. Disagreements between the 2 masters on the extracted elements were resolved by discussion or adjudicated by a third reviewer. The following data items were mainly extracted: study type, published year, technology type, application current in health professions education, and future prospects in health professions education.

## 3. Results

### 3.1 Search and Selection of Publications

The search results from Web of Science, PubMed and Scopus databases yielded a total of 1038 articles based on the eligibility criteria. Four duplicates were removed.842 records were screened out through title and abstract. the remaining 192 full-text studies were assessed and analyzed for eligibility,and157 articles were excluded.Finally,15 articles were included after analysis. The article selection process are as shown in figure 1.which depicts the PRISMA flowchart for identifying, screening, and checking eligibility.

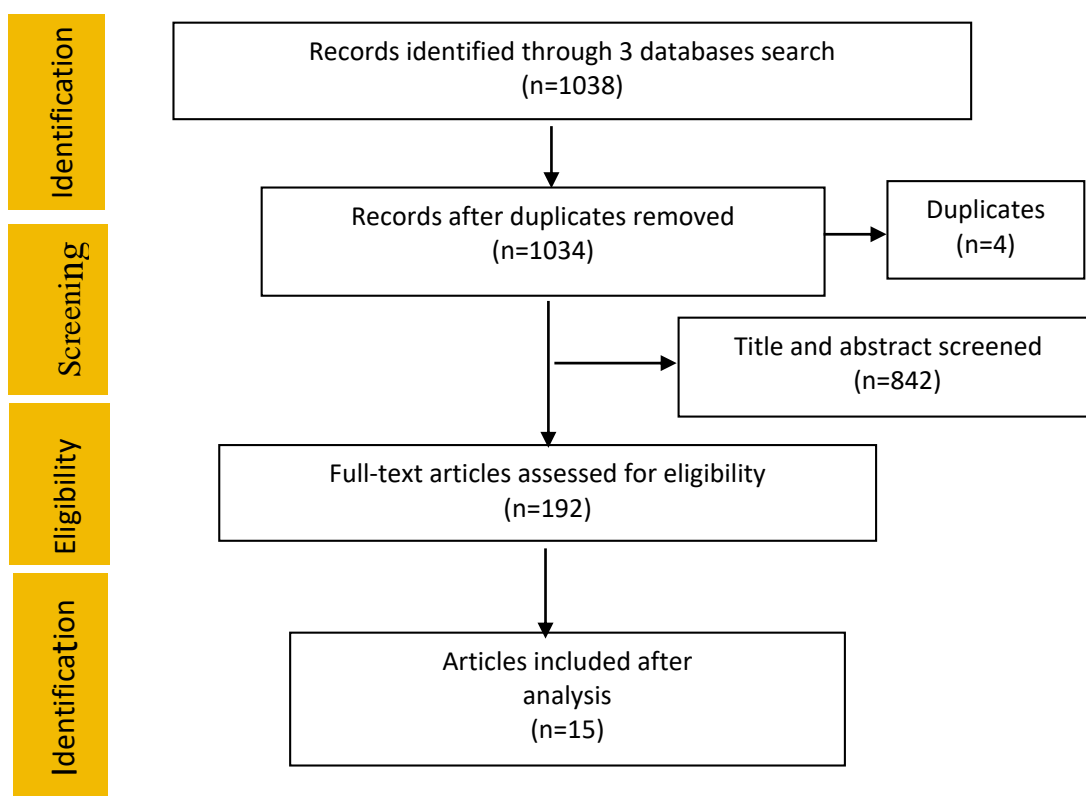


Figure 1. Flowchart of records selection process.

### 3.2 Characteristics of Included Articles

Basic characteristics are as shown in Table 1, focusing on authors' name, technologies used in studies and application areas, results or advantages, and future prospects or suggestions. These articles originate from different countries, including China, South Korea, Turkey, Australia and others.

Table1: Main characteristics of studies included in the research.

Reference	Application Area	Results/Advantages	Future Prospects/Suggestions
Zhao et al,2024 <sup>[12]</sup>	<ul style="list-style-type: none"> <li>Nursing curriculum (midwifery)</li> </ul>	<ul style="list-style-type: none"> <li>Developing comprehensive abilities(independent-study enthusiasm, independent thinking, collaboration, and communication)</li> <li>Higher recognition</li> </ul>	<ul style="list-style-type: none"> <li>Expanding the sample to develop teaching</li> </ul>
Saab et al,2023 <sup>[13]</sup>	<ul style="list-style-type: none"> <li>Nursing curriculum (midwifery)</li> </ul>	<ul style="list-style-type: none"> <li>Highly Satisfied</li> <li>Fostering safe and self-directed learning</li> </ul>	<ul style="list-style-type: none"> <li>It should be aligned with a strong pedagogy and learning outcomes</li> </ul>
Chang et al,2024 <sup>[14]</sup>	<ul style="list-style-type: none"> <li>Nursing education (Intra-venous injection)</li> </ul>	<ul style="list-style-type: none"> <li>Higher acceptance and learning motivation</li> <li>Enhancing skill and process</li> <li>sense of presence and realism</li> </ul>	<ul style="list-style-type: none"> <li>Adding More realistic action</li> </ul>

Cho et al,2024 <sup>[15]</sup>	•Nursing training (pediatric nursing)	<ul style="list-style-type: none"> <li>• Higher handoff self -efficacy</li> <li>• No difference on handoff competence, learning realism and satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>• Meeting needs of students and providing realworld clinical practice</li> </ul>
Chang et al,2021 <sup>[16]</sup>	• Nursing skills (Nasogastric tube care)	<ul style="list-style-type: none"> <li>• Convenient practice</li> <li>• Fast skill learning process</li> <li>• Stress-free learning environment</li> </ul>	<ul style="list-style-type: none"> <li>• Focus on stereognosis aspect and interactive function</li> </ul>
Uslusoy et al,2024 <sup>[17]</sup>	• Nursing curriculum	<ul style="list-style-type: none"> <li>• Better learning motivation and academic achievement</li> </ul>	<ul style="list-style-type: none"> <li>• Elucidating the precise mechanisms</li> </ul>
Rim et al,2024 <sup>[18]</sup>	• Nursing curriculum	<ul style="list-style-type: none"> <li>• Better nursing competency</li> <li>• Better clinical judgment</li> </ul>	<ul style="list-style-type: none"> <li>• Examining performance after training</li> </ul>
Kurt et al,2021 <sup>[19]</sup>	•Nursing training (Injections)	<ul style="list-style-type: none"> <li>• Better knowledge</li> <li>• Better injection skill scores</li> </ul>	<ul style="list-style-type: none"> <li>• It can be used before and during laboratory training and clinical learning.</li> </ul>
Liao et al,2022 <sup>[20]</sup>	• Nursing curriculum	<ul style="list-style-type: none"> <li>• Enhancing disaster preparedness, confidence, and performanc</li> </ul>	<ul style="list-style-type: none"> <li>• Bridge the gap between the lack of disaster trainingand the high demands for disaster preparedness</li> </ul>
Yu et al,2021 <sup>[21]</sup>	• Nursing curriculum (Neonatology)	<ul style="list-style-type: none"> <li>• Expand practice experience</li> <li>• Greater self-efficacy and satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>• Develop programs where multiple learners solve problems together</li> </ul>
Lee et al,2023 <sup>[22]</sup>	• Nursing education (Blood transfusion)	<ul style="list-style-type: none"> <li>• Higher test scores</li> <li>• Higher satisfaction, self-confidence and selfefficacy</li> </ul>	<ul style="list-style-type: none"> <li>• Considering How to combine interests with theoretical framework</li> </ul>
Lee et al,2024 <sup>[23]</sup>	• Nursing curriculum (psychiatric nursing)	<ul style="list-style-type: none"> <li>• Better symptom and violence risk management</li> <li>• Better nurse-patient interaction</li> </ul>	<ul style="list-style-type: none"> <li>• Improving perceived nursing competency</li> </ul>
Oh et al,2023 <sup>[24]</sup>	• Nursing curriculum (Patient safety)	<ul style="list-style-type: none"> <li>• Better knowledge, attitude and performance confidence</li> </ul>	<ul style="list-style-type: none"> <li>• It could be pre-clinical materials for students</li> </ul>
Xie et al,2024 <sup>[25]</sup>	• Nursing curriculum (Geriatric nursing)	<ul style="list-style-type: none"> <li>• Higher positivity and performance evaluation scores</li> <li>• Lower negative affect scores</li> </ul>	<ul style="list-style-type: none"> <li>• Necessary to further enhance user convenience and feedback mechanisms</li> </ul>
Lo et al,2022 <sup>[26]</sup>	•Nursing training (Nasogastric tube feeding)	<ul style="list-style-type: none"> <li>• Higher extrinsic goals,task value and satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>• Solving high cognitive load in the students</li> </ul>

#### 4. Discussion

The metaverse is a virtual space where users can interact with each other and experience specific

clinical context, it involves<sup>[27]</sup> elements of AR,VR,MR, and others<sup>[28]</sup>.Its application in health professions education is a gradual progression that provides a valuable and potential teaching tool. Most of health professions students have a high acceptance of using Metaverse and expected increasing their academic performance by using AR <sup>[29]</sup>,which aligns closely with conclusions of Boduret al<sup>[30]</sup>.Metaverse has already been applied in health professions fields such as health professions curriculum, nursing skills, fostering empathy and so on.

The metaverse has broad application in health professions education, generating a significant impact, mainly focused on some curricula such as anatomy, midwifery, physical assessment, palliative care. Many studies had indicated that the application of metaverse technologies in nursing curricula could yield many benefits, such as improving students' performance, fostering safe and self-directed learning, gaining better self-perceived knowledge and motivation<sup>[13, 31-33]</sup>. Kouchehi et al 2023<sup>[33]</sup> applied IVR to skeletal anatomy education on fifty first-year students and then evaluated their average test score. Finally, they concluded that there was no significant difference in test average score after using IVR or traditional methods for anatomy education, but students had a preference for combination of traditional methods and IVR for learning anatomy. Cho et al 2024<sup>[15]</sup>verified a metaverse-based handoff simulation program on 69 senior health professions students. This program included online course, a metaverse discussion and handoff simulation, results demonstrated that no significant differences in competency, learning realism, or satisfaction between the groups except for better self-efficacy than control group. Influence of metaverse still needs more samples or programs to verify and to be used in many other areas of nursing as a complementing tool rather than a replacement. In addition, students and teachers should be encouraged to be involved in metaverse-based scenario creation and development<sup>[32]</sup>,because user experiences and feelings are decisive and even directly determine the metaverse. A sense of presence is the core of metaverse, which is not just about visual fidelity but also involves a set of interactive experiences.

Health professions skill training is the foundation of health professions education ,serving as an indispensable and vital component, but students usually have limited opportunities to obtain practical experience especially in invasive procedures such as intra-venous injection, blood transfusion<sup>[19, 22]</sup>.The application of metaverse in this field has addressed above challenge in a way. Some studies have indicated that nursing skill training that involves in metaverse technologies has positive impact on academic performance and learning ability, such as increasing knowledge and confidence, higher self-efficacy, better clinical judgment ,expanding practice experience and so on<sup>[22, 34-36]</sup>. Avci et al 2024<sup>[37]</sup> applied MR to the field of intravenous catheter placement skill in second-year health professions students, and produced the result that the experimental group had better satisfaction , self-confidence and procedure performance than control group but no significant difference between groups except self-confidence, which demonstrated that more future research including big sample or deep research is needed to verify the long-term impact of MR.

Another application of the metaverse application in health professions education is developing empathy<sup>[38]</sup>.Health professions students not only need knowledge and procedure skills but also need to develop other skills addressing patients' psychological problems, those with empathy could focus on patients' mental health and provide higher-quality care that alleviates emotional suffering and enhances patient experience<sup>[39]</sup>.It is necessary to achieve a balance between clinical technology improvements and preservation of human care<sup>[39]</sup>.A review pointed out that daily empathic practice would enhance patient care, nursing students' empathy levels were significantly improved immediately after the simulation activity but the long-term outcome of empathy development is unclear<sup>[40]</sup>.

## 5. Limitations and Future Perspectives

As with other research, there are several limitations. Our research only searched three databases, which may have led to omissions. Furthermore, as the metaverse is an emerging and rapidly developing technology cluster, relevant literature is projected to experience explosive growth after 2024; however, the studies included in this review are from before July 2024. It is recommended that future studies broaden the scope of database searches and include a synthesis of newly published literature to overcome these constraints. Then, most of the studies included originate from countries with strong economic conditions, such as China, South Korea, and others as shown above, while research from countries with less developed economies is rare; subsequent research is expected to focus on this area to promote the vigorous development of the metaverse around the world and achieve educational equity.

## 6. Conclusion

The application of metaverse has a great potential to support health professions teachers in different theoretical courses and skills training. However, it requires constant technology innovation and application, continuous validation among health professions students, and targeted strategies to decrease negative impact. In the future, greater application of metaverse in health professions education can facilitate remote training, reducing long-range training costs, improving academic performance and fostering excellent nurses.

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