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Original Article

Analysis of research trends in the healthcare field utilizing extended-reality-based converged contents

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ABSTRACT

Objectives: Extended reality technology offers an innovative opportunity to enhance self-directed learning through interactive processes in healthcare education. This study aims to analyze research trends in the application of extended reality technology-based educational content in the field of healthcare. **Methods:** Through literature search, selection, and exclusion processes based on predefined criteria, we conducted an analysis of domestic healthcare studies employing extended reality technology, ultimately selecting and examining 39 relevant publications. **Results:** The analysis reveals diverse applications of extended reality across various fields such as medicine, dentistry, and nursing. Positive effects, including increased academic satisfaction, immersion, and interest, are observed, alongside challenges like media usage difficulties and cybersickness. **Conclusions:** Future research should focus on the development and application of extended reality-based educational content in diverse healthcare curricula, emphasizing both educational approaches and continuous technological advancements.

Key Words: Augmented reality, Convergence, Healthcare, Research trends, Virtual reality

Introduction

Extended reality (ER) is a technology that fuses the real and virtual worlds to provide new experiences and includes virtual reality, augmented reality, mixed reality, and metaverse. A key feature of ER is that it merges or expands the boundaries between the physical world and digital information, allowing users to have a variety of experiences [1]. Virtual reality consists of visual and auditory elements that immerse the user in a complete virtual environment, creating a life-like experience [2]. This immersion can be used in education and training as a tool for hands-on training and simulation, maximizing learning through interactive experiences within a virtual environment. Augmented reality, on the other hand, superimposes digital information about three-dimensional objects on the real world, increasing interactivity and accessibility of information [3]. Users interact with virtual objects based on their real-world environment and, in the process, experience enhanced information accessibility and expanded perception. Augmented reality contributes to enriching real-world interactions in a variety of fields, including education, entertainment, and industrial design. Metaverses provide virtual spaces where users can interact through avatars and engage in economic and social activities [4]. Metaverses enable new forms of engagement and experience in an environment that blends the virtual world and reality, creating new opportunities in education, business, entertainment, and more. These ER technologies offer new pedagogical approaches in education with the potential to improve intrinsic motivation and academic performance.

According to Edgar Dale's 'active learning', hands-on experience or simulation typically results in a ninefold difference in

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retention compared to reading alone [5]. Compared to traditional textbook-based lectures ER technology can help improve the quality of education by facilitating active participation in learning, boosting comprehension, and providing interactivity, such as real-time feedback. Traditional textbook-centered education is primarily based on methodologies such as lecture, discussion, or flipped classroom [6]. Textbook-based learning poses limitations in the process of understanding three-dimensional objects, structures, and environments, and there may be limitations with hands-on practice due to time and environmental constraints [7,8]. To overcome the limitations of space and time, educational contents developed based on ER technology are increasingly being utilized. Hsieh et al. [9] reported that the application of augmented and virtual reality in medical education can improve the inconvenience of traditional medical practice and education and increase the effectiveness and efficiency of medical services. In contrast, Danciu et al. [10] pointed out that the application of augmented and virtual reality has limitations, such as the need for users to set their own environment and adjust mobile and wearable systems. Nevertheless, the adoption of ER technology provides real-world, experiential learning opportunities and offers the opportunity to acquire specialized knowledge.

Healthcare content related to ER has been developed and studied in various subjects [11-13], but the diversity of tools across fields hinders direct comparisons. Further, research trends on this topic are lacking. Systematic reviews of virtual reality programs in nursing and of augmented reality programs in fields, such asl liberal arts and special education, have been conducted [14,15]. However, there is a lack of literature reviews on educational trends and applications of ER applied to the healthcare field. Therefore, this study aims to shed light on the direction of research on ER in healthcare by analyzing the association between healthcare educational contents based on ER from 2013 to 2023 and general characteristics, the effectiveness of such contents reported in interventional studies, and relevant research trends.

Methods

1. Literature search and inclusion and exclusion criteria

This study extracted literature that met the selection criteria and analyzed research trends among studies on the use of ER-based healthcare contents in Korea. The research trend analysis was conducted through the process of identification of the study question, literature search, literature evaluation, and literature analysis. The literature search was conducted from September 5, 2023, to September 18, 2023, and included literature published in Korean journals <Fig. 1>. The Korean literature was obtained from the National Assembly Library (NAL), Korean studies Information Academic (KISS), Research Information Sharing Service (RISS), and DataBase periodical information academic (DBpia).

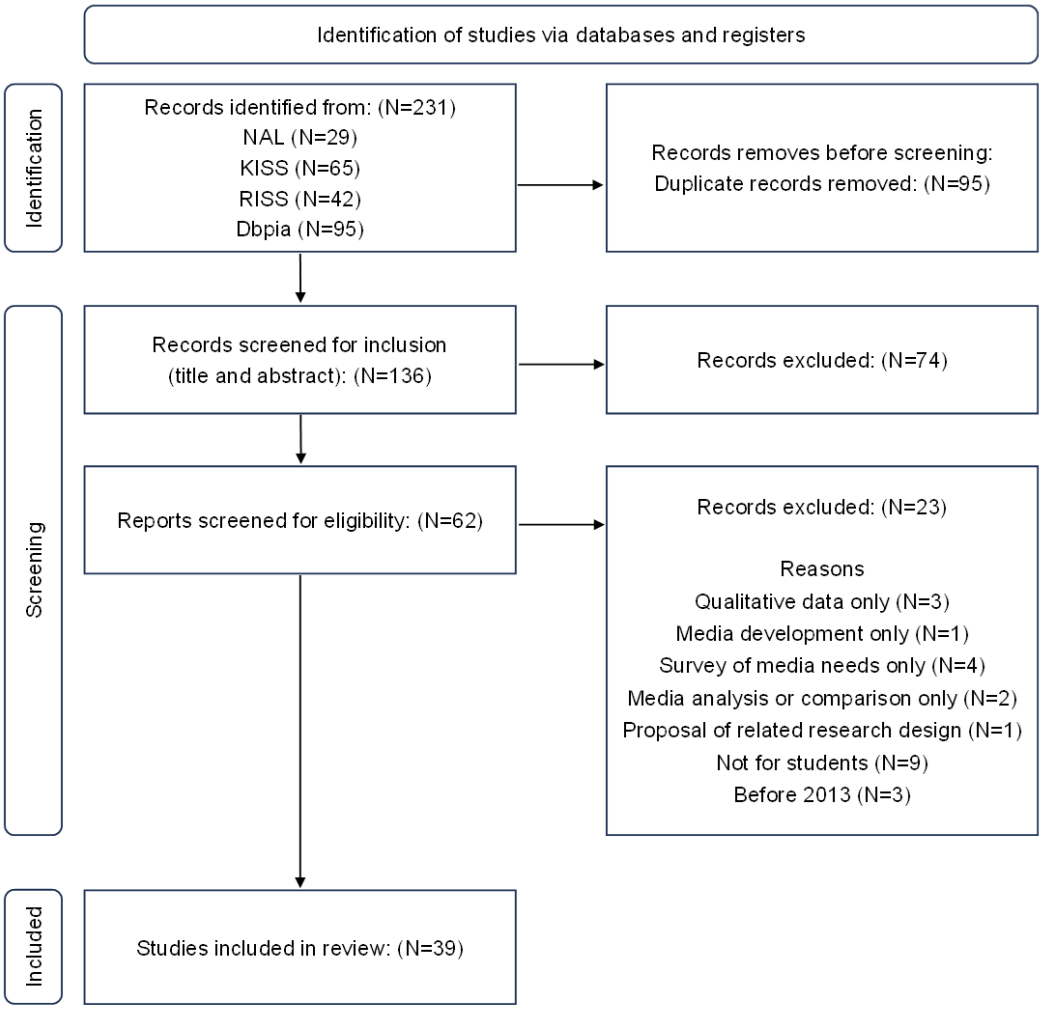

Fig. 1. Flow diagram for data collection. DBpia: DataBase periodical information academic, KISS: Korean studies Information Service System, NAL: National Assembly Library, RISS: Research Information Sharing Service

The search was conducted using combinations of the following keywords: 1) 'healthcare,' 'medicine,' 'dentistry,' 'Korean medicine,' 'nursing,' 'physical therapy,' 'occupational therapy,' 'radiology,' 'clinical pathology,' 'dental hygiene,' and 'dental technician'; 2) 'virtual reality,' 'augmented reality,' 'mixed reality,' and 'metaverse'; and 3) 'education.' A total of two hundred one articles (nineteen articles from NAL, sixty five articles from KISS, forty two articles from RISS, and ninety five articles from DBpia) were generated in the search. After excluding duplicate results, one hundred six articles were reviewed. The titles and abstracts were first reviewed, and seventy four articles, including systematic reviews and theses, were excluded. After the initial screening, the titles, abstracts, and contents of sixty two articles were reviewed. The inclusion and exclusion criteria are shown in <Table 1>. Twenty-three articles were excluded, including qualitative studies, media development studies, media needs surveys, media analysis studies, studies for recommending study designs, studies that do not involve students, and studies published conducted before 2013. As a result, thirty nine articles were selected.

2. Data analysis

The final thirty nine articles were organized according to the objectives of this study to extract general characteristics (year of publication, research method, field, media, sample size, grade, and group), intervention methods, intervention duration, and

measurement variables. Additionally the key interview findings from six mixed-methods studies were analyzed.

Table 1. Paper selection criteria

Type	Inclusion	Exclusion
Paper publication year	2013-2023	Before 2013
Types of literature	Domestic academic journals	Master's thesis, Doctoral dissertation
Study object	Undergraduate student	Children Graduate student Healthcare professional
Study design	Cross-sectional study Experimental studies (Experimental design, Non-experimental design)	Meta-analysis Systematic analysis

Results

1. General characteristics

The thirty nine articles included thirty three quantitative studies and six mixed methods studies published between 2013 and 2023 <Fig. 2>. Quantitative studies were published most often in 2021 and 2022, with twelve articles each, while mixed methods studies were published in 2020 (two articles), 2022 (two articles), 2019 (one article), and 2021 (one article). The content and topics of the analyzed literature are shown in <Table 2>. The disciplines comprised medicine (five articles), dentistry (five articles), nursing (twenty nine articles), radiology (one article), and dental hygiene (two articles). The media used were augmented reality (nine articles), virtual reality (twenty five articles), and metaverse (five articles). The sample size was 50 or less in nineteen articles, 51–100 in fifteen articles, and 101 or more in five articles. Participants were current students, either from the same grade level or from two or more grade levels. There were 20 single-group studies and 19 controlled experimental studies. The extended reality intervention used in the studies included viewing virtual reality video (one article), virtual reality experiences using HMDs (nineteen articles), augmented reality applications (nine articles), and metaverse platforms (five articles) <Table 3>.

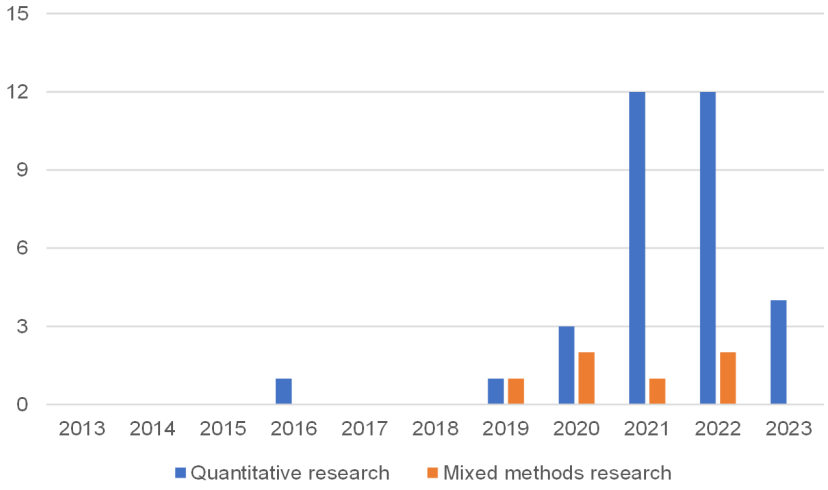

Fig. 2. Bar chart of number of publications by year and research

Table 2. Content and themes of selected articles

Author (yr)	Research method	Field	Subjects	Use of ER	Content and themes
Lee (2019)	Quantitative	Medical	Functional anatomy	Virtual reality	Evaluation of academic satisfaction in virtual reality classes
J eong et al. (2023)	Quantitative	Medical	Structure and function of the human body I	Virtual reality	Comparison of virtual reality anatomy learning and traditional learning experiences
Lee (2022)	Quantitative	Medical	Basic medicine physiology	Metaverse	Evaluation of presence and immersion in classes using metaverse
Lee et al. (2022)	Mixed	Medical	Medical humanities	Metaverse	Evaluation of class experience using metaverse for medical students
Lee (2022)	Quantitative	Medical	Basic medicine physiology	Metaverse	Evaluation of presence and immersion in physiology classes using the metaverse
Kim et al. (2 020)	Mixed	Dental	Clinical practice	Augmented reality	Comparative analysis of user evaluations on virtual pediatric patient simulation
Kim et al. (2020)	Quantitative	Dental	Unspecified	Augmented reality	Development and application of a virtual reality program that allows pediatric patients to experience dental caries diagnosis
Lee et al. (2023)	Quantitative	Nursing	Anatomy	Virtual reality	Usability evaluation of a virtual reality-based anatomy education program
Lim (2021)	Quantitative	Nursing	Adult nursing	Virtual reality	Analysis of differences in learning ability, job performance ability, and self-efficacy before and after virtual reality simulation training
Kim et al. (2022)	Quantitative	Nursing	Unspecified	Virtual reality	Analysis of learning ability, job performance ability, and academic satisfaction before and after virtual reality simulation training
Chae (2021)	Quantitative	Nursing	Unspecified	Virtual reality	Comparative analysis of virtual reality simulation and traditional education methods
Kim (2021)	Quantitative	Nursing	Unspecified	Virtual reality	Development and evaluation of virtual reality content
Ha et al. (2022)	Quantitative	Nursing	Unspecified	Virtual reality	Analysis of job performance ability, self-efficacy, and academic satisfaction in nursing practice using virtual reality
Lee et al. (2021)	Quantitative	Nursing	Adult nursing	Virtual reality	Development and evaluation a nursing education program using virtual reality
Son et al. (2022)	Quantitative	Nursing	Mental health nursing	Virtual reality	Evaluation of learning ability and academic satisfaction when using virtual reality simulation
Kim et al. (2021)	Quantitative	Nursing	Basic nursing arts	Virtual reality	Evaluation of self-efficacy, immersion, and academic satisfaction when using virtual reality
Han et al. (2021)	Quantitative	Nursing	Mental health nursing	Virtual reality	Analysis of differences in motivation and self-efficacy before and after virtual reality classes
Lim et al. (2020)	Quantitative	Nursing	Unspecified	Virtual reality	Self-efficacy and learning ability evaluation before and after virtual reality simulation training
Seo et al. (2016)	Quantitative	Nursing	Unspecified	Virtual reality	Evaluation of immersion and academic satisfaction before and after virtual reality-based practice
Lee et al. (2022)	Quantitative	Nursing	Unspecified	Virtual reality	Development virtual reality program and evaluation of media satisfaction
Lee et al. (2021)	Quantitative	Nursing	Unspecified	Virtual reality	Virtual reality program development and evaluation of usability
Hyun et al. (2020)	Mixed	Nursing	Transfusion nursing	Virtual reality	Correlation analysis of job performance ability, self-efficacy, presence, and immersion in virtual reality education
Jung et al. (2022)	Mixed	Nursing	Unspecified	Virtual reality	Analysis of differences in learning immersion, self-efficacy, job performance ability, and usability between the experimental and control groups of a virtual reality simulation program
You et al. (2021)	Quantitative	Nursing	Unspecified	Virtual reality	Analysis of learning ability and self-efficacy when applying virtual reality simulation scenarios
Oh et al. (2021)	Quantitative	Nursing	Unspecified	Virtual reality	Evaluation of virtual simulation learning experience on self-efficacy and academic satisfaction

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Table 2. (To be continued)

Author (yr)	Research method	Field	Subjects	Use of ER	Content and themes
Ko et al. (2021)	Quantitative	Nursing	Unspecified	Augmented reality	Augmented reality-based application development and academic satisfaction evaluation
Kim et al. (2022)	Quantitative	Nursing	Basic nursing arts	Augmented reality	Evaluation of job ability, self-efficacy, and academic satisfaction during augmented reality-based practical training
Kim et al. (2022)	Quantitative	Nursing	Unspecified	Augmented reality	Evaluation of the effects on academic satisfaction and learning ability during augmented reality-based learning
Kim (2022)	Quantitative	Nursing	Unspecified	Augmented reality	Evaluation of the effects on academic satisfaction and learning ability in augmented reality-based education
Suh et al. (2021)	Quantitative	Nursing	Unspecified	Augmented reality	Evaluation of media satisfaction during augmented reality application classes
Kim (2021)	Quantitative	Nursing	Unspecified	Augmented reality	Evaluation and analysis of learning ability after augmented reality classes
Kim et al. (2022)	Quantitative	Nursing	Unspecified	Augmented reality	Analysis of the effect on learning ability during augmented reality-based learning
An (2019)	Mixed	Nursing	Unspecified	Augmented reality	Usability analysis of learning using augmented reality
Lee et al. (2021)	Mixed	Nursing	Unspecified	Virtual reality	Comparison and analysis of virtual simulation and high fidelity simulation practical training experience
Ahn (2022)	Quantitative	Nursing	Unspecified	Metaverse	Development of metaverse -based content and verify effectiveness
Ahn (2023)	Quantitative	Nursing	Unspecified	Metaverse	Analysis of the effects of metaverse -based content education on self-efficacy and job performance ability
Shim et al. (2020)	Quantitative	Radiology	Radiation therapeuties	Virtual reality	Development of virtual reality content on radiation therapy and evaluation of learning ability, self-efficacy, and academic satisfaction
Choi et al. (2022)	Quantitative	Dental hygiene	Dental radiology practice	Virtual reality	Evaluation of interest, immersion, and motivation using virtual reality media
Lee et al. (2023)	Quantitative	Dental hygiene	Dental morphology	Augmented reality	Analysis of differences in learning ability in practice using augmented reality-based applications

Table 3. General characteristics of included articles

Characteristics	Division	Total	2016	2019	2020	2021	2022	2023
		N(%)	N(%)	N(%)	N(%)	N(%)	N(%)	N(%)
Field	Medicine	5(12.8)	0(0.0)	1(20.0)	0(0.0)	0(0.0)	3(60.0)	1(20.0)
	Dentistry	2(5.1)	0(0.0)	0(0.0)	2(100.0)	0(0.0)	0(0.0)	0(0.0)
	Nursing	29(74.4)	1(3.4)	1(3.4)	2(6.9)	13(44.9)	10(34.5)	2(6.9)
	Radiology	1(2.6)	0(0.0)	0(0.0)	1(100.0)	0(0.0)	0(0.0)	0(0.0)
	Dental hygiene	2(5.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(50.0)	1(50.0)
Media	Augmented reality	9(23.1)	0(0.0)	1(11.1)	0(0.0)	3(33.3)	4(44.5)	1(11.1)
	Virtual reality	25(64.1)	1(4.0)	1(4.0)	3(12.0)	12(48.0)	6(24.0)	2(8.0)
	Metaverse	5(12.8)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	4(80.0)	1(20.0)
Sample size	Less than 50	19(48.7)	1(5.3)	2(10.5)	3(15.7)	6(31.6)	6(31.6)	1(5.3)
	Between 51 and 100	15(38.5)	0(0.0)	0(0.0)	1(6.7)	6(40.0)	6(40.0)	2(13.3)
	More than 101	5(12.8)	0(0.0)	0(0.0)	1(20.0)	1(20.0)	2(40.0)	1(20.0)
Year	1st	5(11.1)	0(0.0)	2(40.0)	0(0.0)	0(0.0)	1(20.0)	2(40.0)
	2nd	12(26.7)	0(0.0)	1(8.3)	0(0.0)	5(41.7)	5(41.7)	1(8.3)
	3rd	12(26.7)	0(0.0)	0(0.0)	4(33.3)	3(25.0)	5(41.7)	0(0.0)
	4th	12(26.7)	1(8.3)	0(0.0)	2(16.7)	6(50.0)	3(25.0)	0(0.0)
	Unspecified	4(8.8)	0(0.0)	0(0.0)	1(25.0)	0(0.0)	2(50.0)	1(25.0)
Group	Single	20(51.3)	1(5.0)	1(5.0)	3(15.0)	7(35.0)	5(25.0)	3(15.0)
	Two	19(48.7)	0(0.0)	0(0.0)	2(10.5)	6(31.6)	9(47.4)	2(10.5)

2. Intervention method, duration, and measurement variables

The interventions comprised virtual reality video viewing (one article), virtual reality experiences using HMDs (nineteen articles), augmented reality applications (nine articles), and metaverse platforms (five articles). The duration of the intervention was 1 week or less (eleven articles), 1–4 weeks (four articles), 1–3 months (eleven articles), and 3 months or more (four articles). Factors measured in the included articles were academic satisfaction, media satisfaction, interest, motivation, immersion, presence, self-efficacy, usability, learning ability, and job performance <Table 4>.

Table 4. Intervention methods, duration, and measurement variables included in the articles

Characteristics	Division	Total	2016	2019	2020	2021	2022	2023
		N(%)	N(%)	N(%)	N(%)	N(%)	N(%)	N(%)
Intervention method	Watch virtual reality video	1	0(0.0)	0(0.0)	0(0.0)	1(100.0)	0(0.0)	0(0.0)
	Virtual reality using head-mounted reality	19	0(0.0)	1(5.3)	5(26.2)	8(42.1)	4(21.0)	1(5.3)
	Augmented reality application	9	0(0.0)	1(11.1)	0(0.0)	3(33.3)	4(44.5)	1(11.1)
	Metaverse platform	5	0(0.0)	0(0.0)	0(0.0)	0(0.0)	4(80.0)	1(20.0)
	Unspecified	5	1(20.0)	0(0.0)	0(0.0)	1(20.0)	2(40.0)	1(20.0)
Intervention duration	Within 1 week	11	0(0.0)	1(9.1)	2(18.2)	2(18.2)	4(36.3)	2(18.2)
	More than 1 week-within 1 month	4	1(25.0)	0(0.0)	1(25.0)	0(0.0)	2(50.0)	0(0.0)
	More than 1 month-within 3 months	11	0(0.0)	1(9.1)	0(0.0)	5(45.4)	4(36.4)	1(9.1)
	More than 3 months	4	0(0.0)	0(0.0)	0(0.0)	2(50.0)	1(25.0)	1(25.0)
	Unspecified	9	0(0.0)	0(0.0)	2(22.2)	4(44.5)	3(33.3)	0(0.0)
Variable	Academic satisfaction	16	1(6.3)	0(0.0)	1(6.3)	8(50.0)	6(37.5)	0(0.0)
	Media satisfaction	3	0(0.0)	0(0.0)	1(33.3)	0(0.0)	2(66.7)	0(0.0)
	Interest	5	0(0.0)	2(40.0)	0(0.0)	1(20.0)	1(20.0)	1(20.0)
	Motivation	3	0(0.0)	0(0.0)	0(0.0)	1(33.3)	2(66.7)	0(0.0)
	Immersion	11	2(18.2)	1(9.1)	1(9.1)	4(36.3)	3(27.3)	0(0.0)
	Presence	12	0(0.0)	0(0.0)	2(16.7)	0(0.0)	10(83.3)	0(0.0)
	Self-efficacy	16	0(0.0)	0(0.0)	3(18.8)	7(43.8)	5(31.3)	1(6.3)
	Usability	14	0(0.0)	3(21.4)	1(7.2)	3(21.4)	5(35.7)	2(14.3)
	Learning ability	17	0(0.0)	1(5.9)	3(17.7)	4(23.5)	9(52.9)	0(0.0)
	Job performance ability	11	0(0.0)	1(9.1)	2(18.2)	4(36.3)	3(27.3)	1(9.1)
	Others	11	0(0.0)	0(0.0)	2(18.2)	3(27.3)	5(45.4)	1(9.1)

3. Specific research objectives and main conclusions

This study conducted a literature review of the educational applicability of ER technology to comprehensively understand the research trends in the field. The 39 included articles analyzed the practical applicability and effectiveness of healthcare education using ER technology, and the research objectives and main conclusions of each article are summarized and categorized in <Table 5>. The research objectives were broadly categorized into three main categories. The first category was 'Evaluating the application and applicability of ER'. These studies focused on evaluating how ER technology can be integrated into the current education system and its effectiveness, as well as confirmed the contribution of ER to learners' engagement and understanding of learning content. The second category was 'Analyzing the ER-based classroom experience and validating the effectiveness'. These studies analyzed how ER is currently utilized in education based on empirical data on the differences between teaching using ER and traditional textbook-centered teaching methods. The third category was 'Discussing the potential of this technology as a new teaching method'. These studies analyzed the possibilities of using ER to overcome the limitations of traditional education methods and present a new education paradigm. Based on the detailed research objectives of each study, we derived four main conclusions: 1) higher student satisfaction, immersion, and interest; 2) more interactive training opportunities for students; 3) the use of ER-based content is independent of previous media experience or gender; and 4) ability to utilize the technology in both online and offline environments.

Table 5. Meaning of virtual and augmented reality learning experiences

Classification	Details
Research objectives	Evaluation of the applicability and potential applications of extended reality
	Analysis and validation of classroom experiences using extended reality
	Discussion on the alternative potential of extended reality as a new educational method
Major conclusion	Elicits high academic satisfaction, interest and immersion
	Provides increased opportunities for student interaction and training
	The use of extended reality content is unrelated to previous media usage experiences or gender
	Extended reality content can be utilized in both online and offline environments

4. Advantages and disadvantages of ER-based training

Based on interview results from six studies, we categorized students' experiences of using ER media into four advantages and three disadvantages <Table 6>. The four advantages of using ER media were as follows: 1) 'acquire knowledge and enhance memory' through the use of three-dimensional images to improve learning and memory of practical procedures; 2) 'interactivity of the learning process' through immediate feedback on action and changes in communication methods; 3) 'increased learning satisfaction and self-directed learning' through motivation through immersion in the situation and increased interest in learning; and 4) 'freedom of learning' through the flexibility of new teaching methods and repeated use of the media. In contrast, the disadvantages mentioned after using ER media were: 1) 'difficulty in using the medium' due to inexperience in operating the device and shaking of the video screen; 2) 'cyber sickness' (dizziness or nausea) during use; and 3) 'limitations in complex situations' due to lack of detailed expressions, systematic lesson design, diverse content, and realism.

Table 6. Pros and cons of learning experiences utilizing ER media

Meanings		Themes
Pros	Acquisition of knowledge and enhancement of memory	Improved retention of performance procedures
		Learning through three-dimensional images
	Interaction with the learning process	Immediate feedback on motor performance
		Shift in communication style
	Enhancement of learning satisfaction and promotion of self-directed learning	Immersive experience in the situation
		Motivated through heightened interest in learning
	Freedom of learning	Flexibility in adopting new teaching methods
		Availability of repetitive media
Cons	Challenges in media utilization	Inexperience with operation equiment
		Orrurrence of video screen shaking phonomenon
	Cybersickness	Reports of symptoms such as dizziness and nausea
		Limited detailed expression
	Limiatations in handiling complex situations	Difficulty in learning within complex situations
		Absence of systematic course design and varied contents
		Necessity to enhance realism comparable to the real world

Discussion

This study aimed to investigate the trends of research on the use of ER contents in healthcare to provide foundational data for utilizing ER technology in healthcare, including dental hygiene, and to shed light on the potential of ER contents and future research directions. A total of 39 studies were selected from Korean databases. The number of published studies on the use of ER in healthcare has steadily increased from one in 2016 to five in 2020 and 14 in 2022. This is believed to be a result of mounting interests in offline and online ER contents owing to advances in technology and environmental factors. However, the majority of these studies were conducted in nursing. In the field of healthcare, diverse curricula and repetitive learning through clinical practicum are essential. Therefore, continued research is needed to explore the application of ER in various healthcare disciplines and courses. The most common duration of ER-based interventions was '1 week or shorter' and '1–3 months'. In order to evaluate the educational outcomes of students in studies that implemented ER, there are various complex conditions that need to be controlled, such as the environment, instructor, and the time and number of times the media is used. However, the included studies were heterogeneous in these aspects, so it is difficult to objectively determine the educational effects of ER technology. Therefore, future studies should expand the use of and analyze the quantitative effects of ER media by maintaining consistency in the duration of the intervention, time, and number of times the media is used.

User evaluations after using ER media showed that ER impacts academic satisfaction, interest and motivation, engagement, learning, and job performance. In dental education, the group that used virtual reality content had higher performance and satisfaction with clinical practicum [16]. This is thought to be due to students' perceived usefulness of three-dimensional visual elements and self-directed learning experiences in acquiring new knowledge compared to textbook-centered teaching methods. In particular, 25 of the 39 studies developed and implemented virtual reality programs. virtual-reality-based practicum can provide students with a structured and varied learning experience through interactivity. There are more cases using virtual reality, as it can be easily applied in games and videos in various fields. However, side effects, such as cyber sickness symptoms, fatigue, and glare, are some drawbacks of the technology. Therefore, when applying virtual reality in learning, learners should be adequately guided on how to use the display and be informed of the possible side effects.

From the six mixed-methods studies analyzed, we identified four advantages and three disadvantages of ER. The three-dimensional elements of ER were beneficial in acquiring knowledge, retaining memory, and facilitating interactions. This suggests that teaching methods based on ER technology can improve students' cognitive and educational outcomes [17]. In contrast, there are concerns about the difficulty of operating the device and side effects from shaking of images on screen. Therefore, ER technologies should be made more user-friendly and accessible in order to expand its use in learning contents [18]. Cybersickness, which often occurs when using ER technologies, can cause physical discomfort to users and impair learning [19]. Therefore, it is necessary to limit the time of use when developing and applying ER content in the future. The studies on ER-based education in healthcare analyzed in this review emphasize the need for continuous development of ER technologies to reproduce complex practicum processes and skills. Findings confirm that ER-based education offers benefits in terms of technical, cognitive, and educational aspects during theoretical learning and practicum. However, given that most studies were conducted in the context of nursing, and that ER has high potential as a new educational approach, future studies should develop educational contents to be used both online and offline in more diverse healthcare disciplines.

Conclusions

In this study, we investigated the research trends regarding the use of ER technologies in healthcare education and provided foundational data that promote the use of these technologies in other fields, such as dental hygiene. We drew the following conclusions:

1. The application of ER technology in healthcare in Korea increased in 2020 and 2021.
2. Of 39 included studies, 29 were conducted in the context of nursing.
3. Of 39 included studies, 25 used virtual reality technology.

This study analyzed cases of education and research utilizing ER in healthcare in Korea. However, most studies were focused in the field of nursing, and many of them utilized virtual reality programs. Therefore, studies should continue to develop and research systematic class designs and learner-centered interaction experiences using diverse forms of ER media in various other disciplines. This calls for in-depth research and technological advancement of ER in healthcare, and the findings can contribute to promoting the use of a new educational approach.

Notes

Author Contributions

Conceptualization: JE Im; Data collection: JE Im, JH Lee, WJ Lee; Formal analysis: JE Im, JH Lee, WJ Lee; Writing-original draft: JE Im, JH Lee, WJ Lee, SR Lim; Writing-review&editing: JE Im, JH Lee, WJ Lee, SR Lim

Conflicts of Interest

The authors declared no conflicts of interest.

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Ethical Statement

None.

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None.

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확장현실 기반 융복합 콘텐츠를 활용한 보건의료 분야의 연구 동향 분석

초록

연구목적: 확장현실 기술은 의료 교육의 대화형 프로세스를 통해 자기주도적 학습 향상의기회를 제공한다. 본 연구에서는 확장 현실 기술을 기반으로 한 교육 콘텐츠를 적용한 보건의료 분야의 연구 동향을 분석하고자 하였다. **연구방법:** 선정기준에 따른 문헌 검색, 선정, 제외 과정을 통해 확장현실 기술을 활용한 국내 보건의료 연구를 분석하여 최종적으로 관련 문헌 39편을 선정 및 검토하였다. **연구결과:** 의학, 치의학, 간호 등 다양한 분야에 걸쳐 확장현실이 적용된 것을 확인하였다. 학업만족도, 몰입도, 흥미 유발 등 긍정적인 효과와 함께 미디어 사용의 어려움 및 사이버 멀미 같은 문제가 관찰되었다. **결론:** 향후 연구에서는 보건의료 분야의 다양한 교과 과정에 대한 콘텐츠 개발과 적용을 통한 교육적 접근과 기술의 지속적 발전이 필요하다.

색인: 가상현실, 보건의료, 연구 동향, 융복합, 증강현실