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Research Analysis on the Utilization of the Metaverse in Education: Focusing on South Korea

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Metaverse provides new experiences and opportunities in the educational environment, and learners can have a more realistic learning experience through various interactions and experiences. The purpose of this study is to analyze research on education using the metaverse that has been conducted in South Korea using big data analysis methods. The aim is to present the direction of future research on education using the metaverse and to help revitalize education through its use. For this purpose, 175 papers including the keywords 'Metaverse' and 'Education' from the Research Information Sharing Service (RISS) were analyzed. Upon examining the main research findings, it was discovered that there was a significant increase in domestic metaverse studies in 2021 and 2022 following the outbreak of COVID-19. Furthermore, using metaverse in school classes was a popular topic, with many studies exploring the combination of metaverse experiences, user satisfaction, effects, language, activity, immersion, and interaction. These findings suggest that this area of research is leading the trend. After conducting topic modeling, it was found that there are numerous studies related to educational use, activity, and virtual reality world in the case of using the metaverse for education. However, research on AI-combined cases and personalized education is still limited. Additionally, there were few studies on negative effects or countermeasures such as addiction or isolation.

Keywords: South Korea, Metaverse, Ecuation, Big data

1. Introduction

The recent rapid change in technology has brought about significant changes in education, which have been accelerated by COVID-19. Among the various technologies that have recently received attention, one of the most noteworthy is the metaverse. While there is currently no consensus definition of the metaverse in the academic world, it implies the meaning of a virtual shared space where Internet space and physical space coexist.

As an immersive virtual world that allows learners to directly participate, the metaverse has the advantage of increasing learners' participation and interest. Its potential as an educational tool is considerable. Through experiences in virtual space, it is possible to provide simulations or experiences that are impossible in reality, and students from a distance can participate

without geographical restrictions. Learners can virtually experience and learn about historical places or universes that were not previously possible in existing online lectures. Additionally, the use of various contents such as games can provide engaging educational experiences. Furthermore, when used in conjunction with customized education services utilizing artificial intelligence technology, it has the advantage of providing optimized learning according to individual abilities and needs. Collaborative classes that focus on learner-centered education have also become prevalent in recent years, and the metaverse allows learners to collaborate with other learners in real-time virtual spaces to have learning experiences tailored to their individual needs and preferences (Mumford, Feldman, Hein & Nagao, 2001). Thus, education using the metaverse is receiving considerable attention in South Korea.

Kim (2022) revealed that the educational use cases of these metaverses in Korea are focused on one-off events or extracurricular activities, but it is necessary to examine recent changes in their use. In fact, metaverse research in Korea is rapidly increasing recently. For example, with the goal of explaining the possibilities and limitations of the educational application of the metaverse, Kye et al. (2021) applied the metaverse to medical education with augmented reality. In foreign countries, many studies using the metaverse for education have also been conducted. Kanematsu et al. (2009) conducted a Problem-Based Learning (PBL) project for college students on the Metaverse platform. There is a study that generally analyzes and introduces the development of the metaverse and its application in education (Singh, Malhotra & Sharma, 2022). Díaz, Saldaña & Ávila (2020) conducted a study on the design, development and use of the metaverse with undergraduate engineering students. At the time of design, various ICT tools were included, and students' evaluation of interaction with the metaverse was also investigated. As for previous research, there have been many studies using Second Life, and the advantages of using virtual space have been investigated (Kemp & Livingstone, 2006). In many different fields, Deep learning networks are widely used that include the segmentation of characteristics, the extraction of essential information, and the classification of illnesses in plants, animals, and fishes (Cho et al., 2024; AlZubi, 2023; Wasik and Pattinson, 2024; Porwal, 2024).

While there have been studies conducted in Korea, and especially recently, they are increasing at a rapid pace (Yoon & Kim, 2021). Therefore, this study aims to analyze the trends of how research on the metaverse as an effective tool for education is progressing in Korea and which topics are mainly being studied. Recent meta-analysis or big data analysis techniques such as text mining or topic modeling are frequently used in research trend analysis papers, and this study intends to utilize these big data techniques (Wang 2018). These results will help identify the right direction for research that uses the metaverse for education.

The research questions of this study are as follows.

1. What is the trend of metaverse research in Korea in 2021 and 2022 after COVID-19, and what topics are important?

2. Based on these results, what are the suggestions for educational research using the metaverse?

2. Method

2.1 Research Target

To collect theses in South Korea, a Research Information Sharing Service (RISS) search was performed. A total of 175 papers were collected by searching for all papers with both 'Metaverse' and 'Education' in the paper title, targeting both domestically registered (candidate) journals and conference papers. The bibliographic information included title, name, and affiliation in Korean and English, as well as the name of the academic journal, year/volume/issue, keywords, and English abstract. The research period was searched without limitation of period to identify the entire range, and the period of the papers from 2016 to February 2023.

The number of papers used in the final analysis was 175, and the specific number of papers by year is shown in
Figure 1.

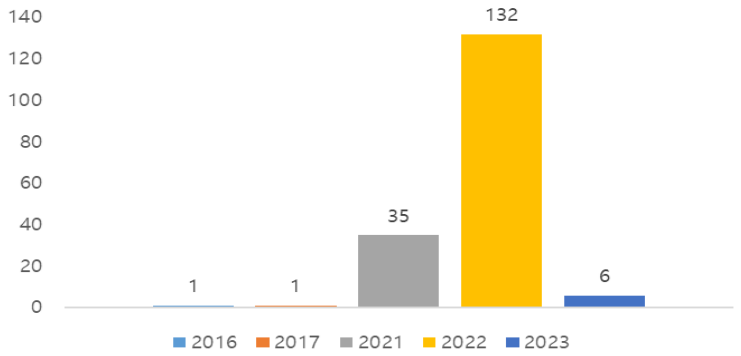

Figure 1: Number of Papers Published by Year

Papers related to the metaverse and education appear to have been in a lull after their first publication in 2016, but began to increase in 2021. It is believed that the number of studies related to the metaverse has increased rapidly as remote classes have expanded since the COVID-19 pandemic in 2019. During the year 2022, 132 studies using the metaverse for education have been published, achieving rapid quantitative growth, and it is expected that continuous research will be conducted.

2.2 Data Analysis

In this study, the analysis was conducted using the Textom program (Textome, 2021). Textom, an open source program, is one of the programs used for text data analysis and visualization. This program provides various analysis functions such as N-gram analysis, word frequency analysis, association analysis, sentiment analysis, and topic modeling, which are mainly used in text data. In addition, visualization tools make it easy to understand and communicate analysis results.

For the analysis, the bibliography information of the thesis to be analyzed was first collected, next data collected from the thesis to be analyzed was refined, then the morpheme was analyzed based on Mecab-ko.

In this process, data was reviewed, unnecessary investigations and conjunctions were sorted out, and terminology was unified. Afterwards, frequency analysis, a representative method of quantitative analysis, was performed to identify the trend of metaverse utilization research in education (Mumford, Feldman, Hein & Nagao, 2001). Lastly, major keywords were analyzed and visualized through N-gram, and U matrix analysis and topic analysis were also performed and visualized. In addition, topic modeling analysis was performed.

3. Results

3.1. Word, Frequency and TF-IDF Analysis

Table 1 and Table 2 show word frequency analysis and TF-IDF (Frequency-Inverse Document Frequency Word Importance Index) of papers related to education using metaverse. Table 1 shows the top 50 key words. In addition to 'metaverse' and 'educate', 'study,' 'learn,' 'platform,' and 'class' are words with a high frequency of appearance in educational papers using the metaverse. These words were predicted to come out a lot because they were applied to education. In addition to this, 'reality,' 'language,' 'experience,' 'satisfaction,' 'activity,' 'develop,' 'immerse,' 'effective,' etc. were included in the top 50. These results can be interpreted that those studies on reality, experience, satisfaction with use, and effects are being actively conducted, and various studies combined with language, activity, immersion, and interaction are leading the flow. Table 2 shows the results of the TF-IDF analysis, which shows the most commonly used weight in text mining, that is, the number indicating how important words are in a specific document. 'class,' 'learn,' 'space,' 'platform', 'student' ranked 1st to 5th, respectively. Figure 2 and Figure 3 show the top 30 frequency words visualized as a word cloud and bar graph.

Table 1: Word and Frequency Analysis

Word and Frequency Analysis			
		n	%
1	metaverse	611	7.31
2	educate	607	7.26
3	study	265	3.17
4	learn	216	2.58
5	platform	191	2.28
6	class	160	1.91
7	space	128	1.53
8	student	124	1.48
9	environment	86	1.03
10	reality	74	0.88
11	technology	72	0.86
12	field	70	0.84
13	world	68	0.81
14	gram	66	0.79
15	school	60	0.72
16	university	58	0.69
17	use	58	0.69
18	time	57	0.68
19	language	56	0.67

20	art	53	0.63
21	experience	52	0.62
22	addition	48	0.57
23	teach	48	0.57
24	effect	47	0.56
25	face	46	0.55
26	sign	45	0.54
27	content	44	0.53
28	era	44	0.53
29	order	43	0.51
30	teacher	42	0.50
31	train	40	0.48
32	satisfaction	39	0.47
33	stage	38	0.45
34	case	38	0.45
35	activity	38	0.45
36	change	38	0.45
37	develop	37	0.44
38	covid	36	0.43
39	apply	36	0.43
40	level	36	0.43
41	concept	35	0.42
42	immerse	34	0.41
43	type	33	0.39
44	interaction	32	0.38
45	characteristic	32	0.38
46	instructor	31	0.37
47	effective	31	0.37
48	problem	29	0.35
49	us	29	0.35
50	limitation	29	0.35

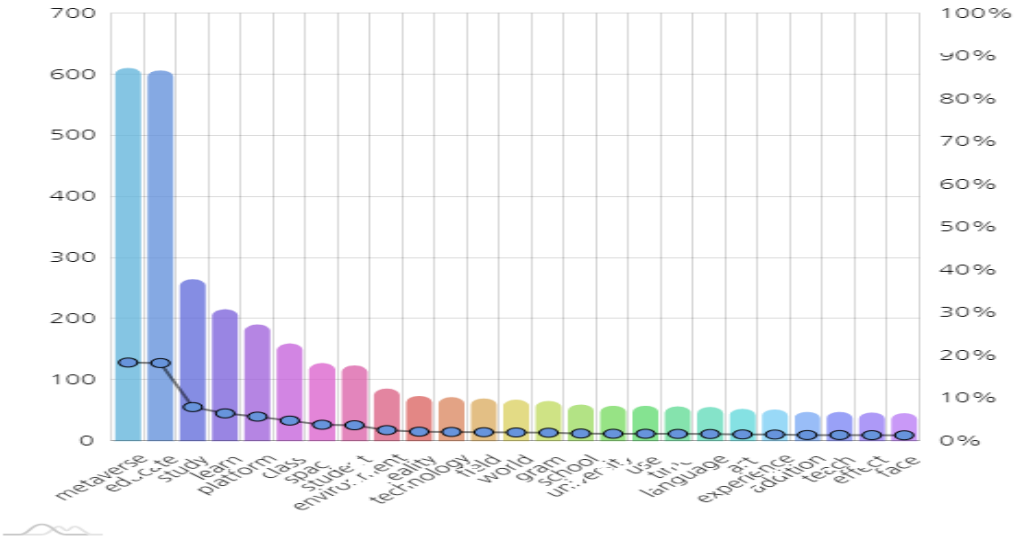

Figure 2: Word and frequency Analysis (Bar chart)

Table 2: TF-IDF Analysis

TF-IDF					
1	class	141.28	26	content	70.16
2	learn	132.56	27	train	68.49
3	space	120.21	28	effect	68.45
4	platform	117.21	29	study	67.74
5	student	116.45	30	teach	66.90
6	gram	113.01	31	time	65.70
7	art	112.24	32	change	65.07
8	language	103.37	33	type	64.22
9	environment	95.13	34	us	63.29
10	reality	94.68	35	educate	62.43
11	technology	94.09	36	generate	62.11
12	world	92.75	37	case	62.03
13	stage	91.41	38	activity	62.03
14	school	91.38	39	instructor	62.00
15	sign	87.57	40	presence	61.83
16	university	86.37	41	factor	61.10
17	field	80.69	42	entrepreneurship	60.67
18	satisfaction	80.23	43	apply	60.17
19	teacher	77.52	44	self	59.03
20	museum	77.09	45	group	59.03
21	era	75.34	46	order	58.65
22	use	74.21	47	concept	58.50
23	experience	74.08	48	immerse	58.22
24	level	74.06	49	model	58.00
25	face	73.35	50	life	57.60

3.2. Word Connection Centrality

Word connection centrality shows how central a word is and how many connections it has. As a result of the analysis, the connection centrality of words such as ‘learn,’ ‘platform,’ ‘class,’ and ‘student’ as well as ‘metaverse,’ ‘study,’ and ‘educate,’ were also at the top. As in the frequency, it can be said that the importance of these keywords was confirmed in the word connection centrality results [Table 3]. Table 4 compares word and frequency analysis and word connection centrality.

Table 3: Word connection centrality

Word connection centrality					
1	metaverse	189.515	26	effect	16.04
2	educate	173.495	27	era	15.798
3	study	91.364	28	teacher	15.778
4	learn	71.04	29	face	14.949
5	platform	62.798	30	case	14.899
6	class	57.152	31	activity	14.444
7	student	43.263	32	satisfaction	14.394
8	space	41.061	33	content	13.747

9	field	26.283	34	stage	12.838
10	environment	25.566	35	develop	12.747
11	reality	25.283	36	level	12.535
12	technology	25.091	37	train	12.212
13	gram	23.455	38	apply	12.02
14	world	22.495	39	instructor	11.99
15	art	22.485	40	immerse	11.98
16	school	22.455	41	change	11.869
17	use	21.283	42	concept	11.707
18	time	19.838	43	interaction	11.545
19	experience	19.232	44	covid	11.465
20	university	18.889	45	characteristic	11.303
21	teach	18.616	46	effective	11.152
22	language	17.899	47	type	10.96
23	sign	17.727	48	problem	10.01
24	addition	16.788	49	limitation	9.737
25	order	16.343	50	us	8.747

Table 4: Word and frequency Analysis vs. Word connection centrality

	frequency	**Word connection centrality**		**frequency**	**Word connection centrality**
metaverse	1	1	sign	26	23
educate	2	2	content	27	33
study	3	3	era	28	27
learn	4	4	order	29	25
platform	5	5	teacher	30	28
class	6	6	train	31	37
space	7	8	satisfaction	32	32
student	8	7	stage	33	34
environment	9	10	case	34	30
reality	10	11	activity	35	31
technology	11	12	change	36	41
field	12	9	develop	37	35
world	13	14	covid	38	44
gram	14	13	apply	39	38
school	15	16	level	40	36
university	16	20	concept	41	42
use	17	17	immerse	42	40
time	18	18	type	43	47
language	19	22	interaction	44	43
art	20	15	characteristic	45	45
experience	21	19	instructor	46	39
addition	22	24	effective	47	46
teach	23	21	problem	48	48
effect	24	26	us	49	50
face	25	29	limitation	50	49

3.3. N-GRAM Network Analysis and Network Visualization Analysis

Table 5 shows the results of N-GRAM network analysis showing the relationship of related words that appear together. Metaverse-platform and educate-metaverse as well as language-

educate, art-educate, school-student, teach-learn, and use-metaverse showed significant relationships. Similar to the frequency analysis, it was found that there was a lot of interest in using the metaverse in classroom instruction, and it was found that the metaverse was actively used in language education or art education. In addition to this, in this study, network analysis was performed to examine structural relationships, and through network analysis, structural characteristics, significant regularities or patterns can be found [Figure 3].

Table 5: N-GRAM network analysis

N-gram			
1	metaverse	platform	100
2	educate	metaverse	60
3	metaverse	educate	59
4	language	educate	33
5	art	educate	30
6	educate	gram	30
7	metaverse	class	23
8	educate	platform	21
9	school	student	20
10	metaverse	space	20
11	class	metaverse	20
12	teach	learn	19
13	use	metaverse	19
14	educate	train	18
15	field	educate	18
16	study	metaverse	17
17	metaverse	learn	16
18	educate	educate	16
19	face	educate	16
20	case	study	14
21	educate	study	14
22	educate	field	13
23	metaverse	language	12
24	learn	satisfaction	12
25	student	metaverse	12
26	gram	metaverse	12
27	sense	reality	12
28	mirror	world	12
29	space	learn	11
30	metaverse	use	11
31	study	study	11
32	metaverse	study	10
33	learn	educate	10
34	educate	class	10
35	space	educate	10
36	educate	era	10
37	mz	generate	10
38	platform	metaverse	10
39	characteristic	metaverse	10

40	space	metaverse	10
41	self	efficacy	10
42	concept	metaverse	10
43	metaverse	field	9
44	educate	system	9
45	change	educate	9
46	class	learn	9
47	sign	educate	9
48	learn	metaverse	9
49	environment	metaverse	9
50	study	educate	9

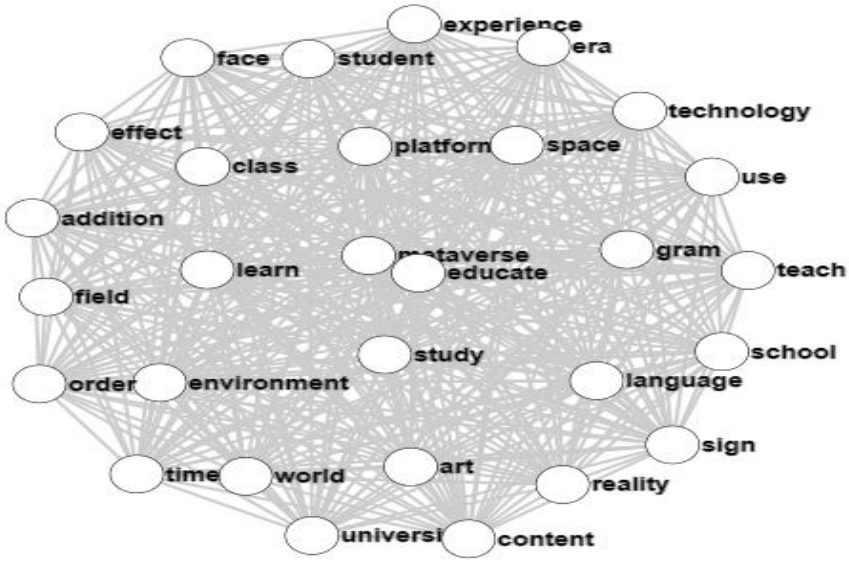

Figure 3: Network Analysis

3.4. Topic Modeling Analysis

In this study, a topic modeling analysis was performed to infer a topic by grouping words with similar meanings. The number of topics was set to three, which were far apart and did not overlap, but the distance between topics was far and did not overlap. Looking at Figure 4, circle number 1, which has the largest circle size, can be said to be the main topic. Table 6 shows the frequently mentioned words for each topic. This first cluster includes keywords such as educate, metaverse, study, platform, learn, class, student, space, gram, environment, field, era, university, and use, and is named ‘Educational Use’. The second cluster included keywords such as 'effect' in addition to metaverse, learn, study, educate, student, space, class, platform, art, world, level, school, stage, teacher, experience, use, and teach. It was named 'Educational Activity'. Finally, the third cluster included keywords such as metaverse, educate, class, platform, learn, study, space, language, reality, technology, environment, world, student, field, museum, and content, which were classified as 'Virtual Reality World'. From these results, it can be seen that in the case of studies using the metaverse for education, there are

many studies related to Educational Use, Activity, and Virtual Reality World. On the other hand, research on cases combined with artificial intelligence is still lacking, and research on personalized education is also lacking. In addition to this, there were few studies on negative effects or countermeasures such as addiction or isolation.

In particular, recently, interest in digital citizenship, which means understanding and complying with personal information protection, copyright, and ethical issues while using digital technology, is increasing, and research on this seems to be necessary.

Research need to be done to teach students digital citizenship, i.e., to teach students to protect their privacy and respect issues such as copyright and plagiarism. Through this, students who use the metaverse should be able to help respect others within the platform and not engage in violence or discriminatory behavior. It will also help them to consider and pay attention to copyright and plagiarism issues when creating metaverse content. In metaverse-related studies, these should be more actively conducted so that education related to a healthy metaverse can be made.

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Table 6: Topic & Keywords

Topic	keywords
1. Educational Use	educate, metaverse, study, platform, learn, class, student, space, gram, environment, field, era, university, use, technology, face, addition, effect, change, school, satisfaction, sign, develop, order, reality, time, case, covid, direction, teach
2. Educational Activity	metaverse, learn, study, educate, student, space, class, platform, art, world, level, school, stage, teacher, experience, use, teach, time, group, train, gram, activity, interaction, concept, reality, environment, characteristic, effect, instructor, university
3. Virtual Reality World	metaverse, educate, class, platform, learn, study, space, language, reality, technology, environment, world, student, field, museum, content, time, exhibition, life, type, train, school, university, experience, model, topic, data, sense, addition, teach

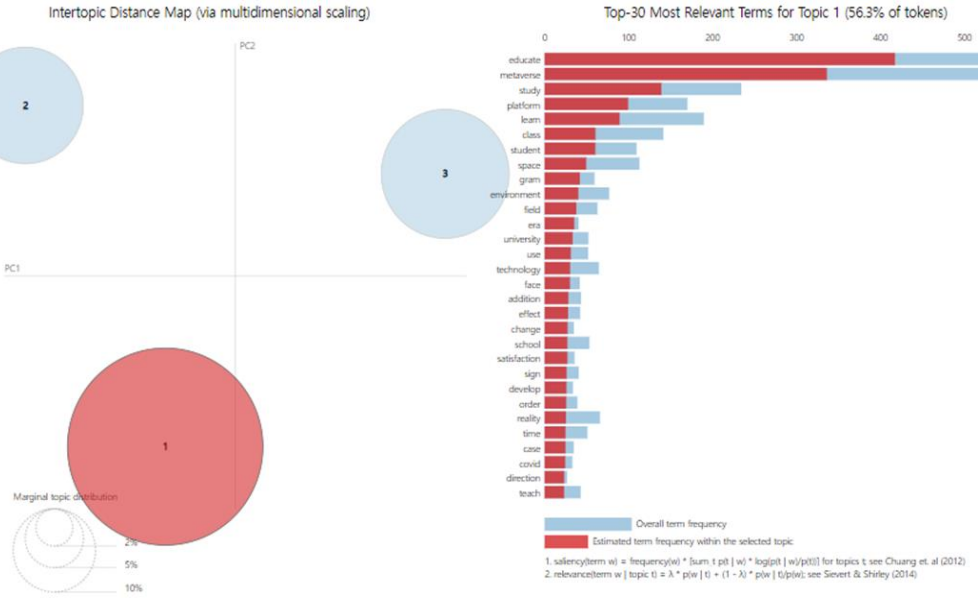

Figure 4: Topic Distribution Chart

4. Conclusion and Suggestion

The purpose of this study is to analyze research trends by selecting and analyzing domestic academic papers that include the keywords 'metaverse' and 'education' in their titles through integrated search of RISS. After examining the main research results, it was found that there was a sharp increase in domestic metaverse studies in 2021 and 2022 after COVID-19. In addition to 'metaverse' and 'education', the keywords 'study', 'learn', 'platform', 'class' and 'reality', 'language', 'experience', 'satisfaction', 'activity', 'develop', 'immerse', 'interaction', and 'effective' were frequently mentioned or treated as important. These results suggest that using metaverse in school classes is being heavily researched, and various studies are being conducted that combine the experience of using the metaverse, satisfaction with use, and

effects, as well as language, activity, immersion, and interaction.

Examining the results of topic modeling, it was found that there are many studies related to Educational Use, Activity, and Virtual Reality World in cases of studies using the metaverse for education. However, research on cases combined with artificial intelligence is still lacking, and research on personalized education is also lacking. Furthermore, there were few studies on negative effects or countermeasures such as addiction or isolation.

Among these, research combining metaverse and artificial intelligence technology is very important to build an effective learning environment in the field of education. If artificial intelligence technology is used, it is possible to provide personalized learning contents by analyzing the learner's personality, learning performance, interests, career path, etc., or to provide customized learning services tailored to the learner's characteristics by monitoring the learner's learning process. Combining this artificial intelligence with the metaverse will enable learner-customized education on the metaverse. Also, on the metaverse that interacts with learners, artificial intelligence can help learners have natural conversations or provide appropriate answers to learners' questions. In addition to this, teachers can evaluate learners to identify areas for improvement and help them learn.

The metaverse is still in its infancy, and programs that can be effectively applied in the field of education are currently being developed. There are research results that suggest that the metaverse can more effectively change the way people interact with content, so more active research is needed. In particular, it will be necessary to investigate the impact of using metaverse on not only academic achievement but also creative competency and critical thinking, or research on how to consider the needs and preferences of individual learners. Additionally, research on learning ethics, privacy, and security will be essential.

To make educational research using the metaverse more active, it will be necessary to support metaverse-related research and induce learners' participation. Recently, support related to the metaverse is increasing, and it will be necessary for the government, universities, and research institutes to provide programs that support educational research using the metaverse, and to help researchers actively conduct research. On the other hand, it will be important to increase interest and understanding of metaverse education. It will be necessary to hold metaverse lectures, educational experiences, and educational events that learners can participate in to induce participation and to collect learners' opinions to develop research.

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