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Analysis of University Students' Educational Needs and Perceptions of Metaverse-Related Technology

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ABSTRACT

The purpose of this study is to investigate students' perceptions and their educational needs regarding metaverse technology in order to effectively apply metaverse technology to university education. To this end, we surveyed university students' personal experiences with Metaverse technology, their perceptions based on UTAUT (Unified theory of acceptance and use of technology), and their educational needs, and analyzed differences according to student characteristics. As a result of this study, it was determined that students used metaverse-related technology for personal needs and interests such as games, SNS (Social Network Service), meetings, and event participation, and overall, they perceived positively the application of metaverse technology to university education. It was found that students in science and engineering departments showed a more active attitude toward metaverse technology for personal innovation than students in arts and physical education departments. Additionally, male students expected that they would be able to acquire the necessary knowledge more easily than female students if metaverse technology was used in university education. Students recognized that social-based platforms were the most suitable type of metaverse platform for university education. As a result of the IPA (Importance-Performance Analysis) analysis of university education applying Metaverse technology, the areas that should be prioritized are 'metaverse basic theory education (A1)' and 'use in hands-on experiment classes (B3)'. The results of this study provided information on university students' perceptions and needs of metaverse technology, and are expected to be helpful in exploring specific strategies for applying metaverse technology to future university education.

1. Introduction

The Metaverse, which is being discussed as a new online-based learning environment and education method after the pandemic, has been studied in various ways in the field of education (Lee & Han, 2022; Lee et al., 2023). Metaverse is a compound word of 'META' and 'UNIVERSE', with 'META' meaning virtual and transcendent, and 'UNIVERSE' meaning world, meaning a three-dimensional virtual world. The term "metaverse" encompasses a wide range of technologies and concepts that collectively aim to create immersive, interconnected virtual worlds where users can interact, socialize, and work. Some major types of technologies related to the metaverse include Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and eXtended Reality (XR) (Park, 2021).

Recently, many universities have conducted research applying not only the game-based Metaverse platform but also social-based Metaverse and Metaverse technology for online collaboration to promote interaction and communication with students and improve learning performance in a non-face-to-face environment (Jang, 2021; Kim & Kang, 2023). As results of these studies, it was argued that in a metaverse-based class environment, interaction with avatars and spatial movement can promote students' sense of learning presence, increase immersion, and increase interest and satisfaction (Lee & Park, 2020; Jeong et al., 2021; Kang et al., 2022). In addition, the results showed that learners who experienced learning presence and active interaction hoped to participate in classes using the metaverse (Lim et al, 2021; Do, 2024). There may be differences in the perception and acceptance of metaverse classes depending on the learner's grade, major, and learning style (Yang et al., 2022), and it was found that lower grade students had a more positive perception of the metaverse learning environment virtual campus than higher grade students (Jeong & Ryu, 2024).

Furthermore, in the process of applying metaverse technology to university education, there was a need to consider the personal characteristics of students who accept new technology (gender, major), dependence on technology, ethical issues, educational effectiveness, and impact on physical health. Therefore, in order to effectively apply metaverse technology to university education, it is necessary to investigate students' personal experiences, awareness of the characteristics of metaverse technology, and perceptions and needs regarding educational content and methods of use of metaverse technology (Park, 2021; Han & Noh, 2021).

Accordingly, this study investigated students' perceptions of metaverse technology and their educational needs for metaverse technology based on UTAUT (Unified Theory of Acceptance and Use of Technology), a theoretical model related to technology acceptance that can affect the intention to use metaverse technology. Through this, we analyzed personal experiences with metaverse-related technologies, analyzed differences in perception of metaverse-related technology characteristics according to students' characteristics (gender, major), analyzed awareness of metaverse technology application and platform types in liberal arts and major education in university education, and analyzed needs for university education that applies metaverse technology (IPA: Importance-Performance Analysis). We aim to provide important information that can impact learning outcomes in the process of applying metaverse-related technologies to university education.

2. Research Method

2.1 Participants

The participants were 190 undergraduates (50.0% female, 50.0% male) from various disciplines at a metropolitan university in the Republic of Korea. They were contacted by email and asked to participate in the online survey. Using Google Forms, we explained the concept of this study to students before the survey and obtained their consent to the collection and use of their personal information in accordance with the Personal Information Protection Act. So, there were a total of 190 students who agreed to this information collection and voluntarily responded to the survey in the winter of 2023. The profile of participants is presented in Table 1.

Table 1. Participant demographics

Category		Frequency(%)
Gender	Male	95(50.0)
	Female	95(50.0)
Grade	1st year	55(28.9)
	2nd year	74(38.9)
	3rd year	52(27.4)
	4th year	9(4.7)
Major	Humanities and social science	83(43.7)
	Science and engineering	72(37.9)
	Art, music, and physical education	35(18.4)
Total		190(100.0)

2.2 Measure

A questionnaire was developed as shown in Table 2. to investigate the educational needs and perception of Metaverse-related technology among university students. The questionnaire was revised and supplemented through continuous discussion by a research team composed of experts who have research expertise in Educational Technology and Metaverse. The questionnaire consisted of 44 items in the four categories drawing reference from previous studies: personal experience, personal characteristics, UTAUT (Unified Theory of Acceptance and Use of Technology)-based perspective, educational needs of Metaverse-related technology (Han & Noh, 2021; Kim & Lee, 2020; Venkatesh et al., 2003; Cho, 2021; Kye & Kim, 2008).

First, in the 'Personal experience (2 items)' section, we investigated students'use of Metaverse technology and their experience participating in education related to Metaverse technology. Second, in the 'Personal characteristics (17 items)' section, students' 'anticipation', 'personal innovation', 'perceived enjoyableness', 'presence', 'interaction', 'learning flow', and 'ethical considerations' about metaverse technology were investigated. Third, in the perspective section based on 'UTAUT (8 items)', 'effort expectancy', 'performance expectancy', 'social influence', and 'behavioral intention' were investigated.

Lastly, in the 'educational needs' section, the requirements for university education using the metaverse were investigated, and the areas that should be applied with the highest priority were investigated through IPA (Importance-Performance Analysis) analysis. The reliability coefficient (Cronbach α) of the questionnaire was 0.92.

Table 2. Contents of the questionnaire for survey

Category	Items	Type of item	Number of item
Personal experience	Experience using metaverse-related technologies (XR, VR, AR, etc.)	Optional question	1
	Experience participating in metaverse-based education	Optional question	1
Personal characteristics	Anticipation	Likert question	1
	Personal innovation	Likert question	4
	Perceived enjoyableness	Likert question	4
	Presence	Likert question	2
	Interaction	Likert question	2
	Learning flow	Likert question	2
	Ethical considerations	Likert question	2
UTAUT	Effort expectancy	Likert question	2
	Performance expectancy	Likert question	2
	Social influence	Likert question	2
	Behavior intention	Likert question	2
Educational needs	Applicability of metaverse technology in liberal arts education	Optional question	1
	Applicability of metaverse technology in major education	Optional question	1
	Metaverse platform suitable for university education	Optional question	1
	Importance and performance of basic theory education related to metaverse technology	Likert question	2
	Importance and performance of education on metaverse-related technologies	Likert question	2
	Importance and performance of lecture-style class using metaverse technology	Likert question	2
	Importance and performance of discussion class using metaverse technology	Likert question	2
	Importance and performance of hands-on experiment class using metaverse technology	Likert question	2
	Importance and performance of team activity-oriented class using metaverse technology	Likert question	2
	Importance and performance of online or blended class using metaverse technology	Likert question	2
Total			44

2.3 Procedure

In this study, the following analysis method was used to examine university students' perceptions of metaverse-related technologies and their educational needs.First, frequency analysis was performed on the response data to the optional questions about 'personal experience' and 'educational needs' regarding metaverse-related technologies, and the frequencies and response ratios were derived.

Second, differences in perception of metaverse-related technologies according to university student characteristics (gender, major) were statistically verified using the IBM SPSS program version 22.0 (IBM Corp., Armonk, NY). To confirm normality, which is the basic assumption of parametric statistics, the Kolmogorov-Smirnov test was performed on each dependent variable to confirm the normality of each dependent variable ($p>.05$). Differences by gender were analyzed using an independent samples t-test, and differences by major were analyzed by one-way ANOVA. If there were differences by major, Dunnett T3 analysis, a post hoc test, was conducted to confirm significant differences between majors.

Third, the difference in importance and performance of university education using metaverse-related technology was analyzed using t-test and IPA matrix. IPA analysis is an evaluation technique that simultaneously compares and analyzes the relative importance and degree of performance of each attribute and is used as a method to evaluate the operational status and find areas for improvement in various fields such as marketing, education, and economics (Lee et al., 2019; Martilla & James, 1977). The first quadrant of the IPA matrix is an area of high importance and high performance, and can be seen as an area that must maintain the current status quo. Quadrant 2 is an area of high importance, but low level of performance, and can be viewed as an area that needs to be pursued with priority compared to other areas. Quadrant 3 is an area of low importance and performance, and can be viewed as a low-priority task area with less importance than the priority task area. Quadrant 4 is an area of low importance, but high performance, and can be classified as an area where excessive efforts are being made to implement elements of low importance.

3. Results

3.1 Analysis of personal experience of Metaverse technology and education

The results of responses regarding experiences using metaverse-related technology and participating in metaverse-related education are presented in Table 3. Among the students, 126 (67.4%) had experience using metaverse-related technologies, and 62 (32.6%) had no experience using them. In addition, 37 students (19.5%) had participated in metaverse-related education, and 153 students (80.5%) had not participated.

In other words, it was understood that students used metaverse-related technology for personal needs and interests such as games, SNS, meetings, and event participation rather than as a form of education. In particular, there have been cases of universities using metaverse platforms such

as Gathertown in the recent pandemic situation to conduct entrance ceremonies, orientations, MTs, festivals, etc., so it can be seen that students' experience in using metaverse technology is high.

Table 3. Personal experience of Metaverse technology and education

Category	Frequency(%)	
Do you have any experience using metaverse technology (XR, VR, AR, etc.)?	Yes	128(67.4%)
	No	62(32.6%)
Have you ever participated in metaverse education?	Yes	37(19.5%)
	No	153(80.5%)

3.2 Analysis of differences in perceptionof Metaverse technology characteristics according to student characteristics

3.2.1 Gender

The difference in perception of metaverse technology characteristics according to the student's gender are presented in Table 4. Male students scored higher than female students in the areas of 'anticipation', 'personal innovation', 'perceived enjoyableness', 'presence', 'interaction', and 'learning flow' regarding the use of metaverse technology. Among these, male students were found to have a statistically significantly higher perception than female students in 'personal innovation (P5, p=.046)', 'presence (X1, p=.023)', and 'interaction (X3, p=.031)'. In other words, it was found that male students had a stronger will to learn metaverse technology, higher awareness of the presence that felt similar to the actual situation, and higher interactions led to more sensory stimulation. However, in the area of 'ethical consideration', male students perceived higher in the X7 (p=.014) item and female students perceived higher in the X8 (p=.028) item. In other words, due to the use of metaverse technology, it was found that male students were more strongly aware of vomiting and nausea, and female students were more aware of eye stiffness.

Table 4. Differences in personal characteristics of Metaverse technology by gender

Category		Male		Female		t
		Mean	SD	Mean	SD	
Anticipation	**P1**: I am looking forward to the use of metaverse technology in university education.	4.00	0.91	3.86	0.94	1.018
Personal innovation	**P2**: I enjoy using new technology.	4.11	1.01	3.71	1.18	2.522
	P3: Compared to my friends, I am good at accepting new technology.	4.07	1.00	3.63	1.08	2.921
	P4: Compared to my friends, I usually use new technology first.	3.61	1.19	3.04	1.12	3.394
	P5: When I hear about a new technology, I tend to find and learn how to use it.	4.00	0.93	3.53	1.06	3.267*

Table 4. Cont.

Category		Male		Female		t
		Mean	SD	Mean	SD	
Perceived enjoyableness	**P6**: I think metaverse education will be fun and interesting.	4.06	0.89	3.78	1.04	2.013
	P7: I think metaverse education will be fun and enjoyable just by looking at various functions.	4.00	0.99	3.72	0.96	2.006
	P8: I think the content composition of metaverse education will be relatively diverse and interesting.	4.08	0.93	3.87	0.99	1.509
	P9: I think I'll be satisfied with the fact that I'm using a new technology related to metaverse.	4.11	0.90	3.82	1.02	2.031
Presence	**X1**: Metaverse education is likely to feel very similar to real education (face-to-face education, field training, etc.).	3.44	1.29	3.03	1.13	2.325*
	X2: People or objects appearing in metaverse education are likely to feel real.	3.24	1.29	2.88	1.19	1.989
Interaction	**X3**: In metaverse education, the degree to which the five senses are stimulated and felt is likely to be very large.	3.26	1.31	3.29	1.10	-0.119*
	X4: Metaverse education seems to be able to supplement the direction of education according to the user's response.	4.06	0.87	3.86	0.96	1.5
Learning flow	**X5**: I feel like I'm going to lose track of time while participating in metaverse education.	3.53	1.16	3.26	1.08	1.618
	X6: In metaverse education, I think I will be immersed as if it were a real situation.	3.55	1.26	3.08	1.12	2.679
ethical considerations	**X7**: Metaverse education is likely to cause nausea and vomiting.	2.86	1.39	2.80	1.12	0.345*
	X8: It is likely that the eyes will feel stiff due to the continuous use of HMD devices in metaverse education.	3.49	1.12	3.65	0.92	-1.062*

*p<0.05

3.2.2 Major

The difference in perception of metaverse technology characteristics according to the student's major are presented in Table 5. The areas where statistically significant differences between majors were P3 (p=.040) and P5 (p=.039) items among 'personal innovation'. As a result of conducting Dunnett T3 analysis, a post hoc test, to confirm significant differences between majors, science and engineering students perceived individual innovation more than art, music, and physical education students. In other words, when science and engineering students heard about metaverse technology than art, music, and physical education students, they found that they had a stronger willingness to accept and learn more easily than their fellow friends.

Table 5. Differences in personal characteristics of Metaverse technology by major

Category		Major	Mean	SD	F
Anticipation	P1	Humanities and social science	3.93	1.03	0.073
		Science and engineering	3.96	0.90	
		Art, music, and physical education	3.89	0.72	
Personal innovation	P2	Humanities and social science	3.71	1.18	2.109
		Science and engineering	3.63	1.08	
		Art, music, and physical education	3.04	1.12	
	P3	Humanities and social science	3.73	1.09	3.264*
		Science and engineering	4.10	1.02	
		Art, music, and physical education	3.63	1.00	
	P4	Humanities and social science	3.19	1.22	2.497
		Science and engineering	3.57	1.20	
		Art, music, and physical education	3.14	1.00	
	P5	Humanities and social science	3.65	1.12	3.314*
		Science and engineering	4.00	0.92	
		Art, music, and physical education	3.54	0.92	
Perceived enjoyableness	P6	Humanities and social science	3.90	1.09	0.510
		Science and engineering	4.00	0.93	
		Art, music, and physical education	3.80	0.80	
	P7	Humanities and social science	3.86	1.03	1.104
		Science and engineering	3.96	1.00	
		Art, music, and physical education	3.66	0.84	
	P8	Humanities and social science	3.89	1.05	0.905
		Science and engineering	4.10	0.92	
		Art, music, and physical education	3.94	0.84	
	P9	Humanities and social science	3.87	1.08	0.832
		Science and engineering	4.07	0.89	
		Art, music, and physical education	3.97	0.86	
Presence	X1	Humanities and social science	3.14	1.17	1.506
		Science and engineering	3.43	1.33	
		Art, music, and physical education	3.06	1.14	
	X2	Humanities and social science	3.04	1.19	0.687
		Science and engineering	3.18	1.37	
		Art, music, and physical education	2.89	1.13	
Interaction	X3	Humanities and social science	3.34	1.24	0.318
		Science and engineering	3.26	1.29	
		Art, music, and physical education	3.14	0.97	
	X4	Humanities and social science	3.95	0.94	0.637
		Science and engineering	4.04	0.88	
		Art, music, and physical education	3.83	0.99	
Learning flow	X5	Humanities and social science	3.49	1.09	1.988
		Science and engineering	3.44	1.19	
		Art, music, and physical education	3.06	1.06	
	X6	Humanities and social science	3.24	1.22	1.484
		Science and engineering	3.50	1.27	
		Art, music, and physical education	3.11	1.05	
ethical considerations	X7	Humanities and social science	2.77	1.22	0.190
		Science and engineering	2.86	1.36	
		Art, music, and physical education	2.91	1.15	
	X8	Humanities and social science	3.54	0.98	0.069
		Science and engineering	3.60	1.12	
		Art, music, and physical education	3.60	0.95	

*p<0.05

3.3 Analysis of differences in perception of metaverse technology based on UTAUT according to student characteristics

3.3.1 Gender

The differences in perception of metaverse technology based on Unified Theory of Acceptance and Use of Technology (UTAUT) according to the student's gender are presented in Table 6. Male students scored higher than female students in the areas of "effort expectancy", "performance expectancy", "social influence" and "behavior intention" for the use of metaverse technology, but there was a statistically significant difference only in "performance Behavior" U3 (p=.043) and "social influence" U6 (p=.004) items. In other words, male students expect that using metaverse technology will make it easier to acquire the knowledge needed at university than female students, and there is a higher perception that the experience of using metaverse technology will be taken for granted in future industrial sites.

Table 6. Differences in perception of metaverse technology based on UTAUT by gender

Category		Male		Female		t
		Mean	SD	Mean	SD	
Effort expectancy	**U1**: It will be easy to learn how to utilize metaverse technology.	3.68	1.06	3.15	1.03	3.548
	U2: It is likely to learn learning contents more easily through practice using metaverse technology than field practice.	3.38	1.27	3.13	1.17	1.430
Performance expectancy	**U3**: It seems that it will be easier to acquire the knowledge necessary for universities through metaverse technology.	3.48	1.23	3.38	1.03	0.575*
	U4: After the metaverse education, the ability to actually perform what has been learned is likely to improve.	3.75	1.11	3.48	0.94	1.760
Social influence	**U5**: Recently, I think the introduction of metaverse education has become socially common.	3.28	1.21	3.18	1.04	0.643
	U6: I think I will take the experience of education using metaverse technology for granted in the industrial field where I will enter.	3.45	1.17	3.42	0.91	0.069**
Behavior intention	**U7**: If metaverse education is introduced to universities, I am willing to participate.	3.99	0.93	3.63	0.91	2.681
	U8: If metaverse education is introduced to universities, I am willing to recommend it to my colleagues.	3.87	0.99	3.59	0.91	2.063

*p<0.05, ** p<0.01

3.3.2 Major

The differences in perception of metaverse technology based on UTAUT according to students' majors are presented in Table 7. The area where statistically significant differences between majors appeared was U1 (p=.038) item in 'effort expectancy'.

As a result of conducting Dunnett T3 analysis, a post hoc test, to confirm significant differences between majors, it was found that students in science and engineering departments recognized that it would be easier to learn how to use metaverse technology than students in Humanities and social sciences and arts and physical education departments.

Table 7. Differences in perception of metaverse technology based on UTAUTby major

Category		Major	Mean	SD	F
Effort expectancy	U1	Humanities and social science	3.29	1.10	3.325*
		Science and Engineering	3.67	1.08	
		Art, Music, and Physical Education	3.20	0.93	
	U2	Humanities and social science	3.25	1.28	0.113
		Science and Engineering	3.29	1.26	
		Art, Music, and Physical Education	3.17	1.01	
Performance expectancy	U3	Humanities and social science	3.48	1.18	0.387
		Science and Engineering	3.46	1.19	
		Art, Music, and Physical Education	3.29	0.89	
	U4	Humanities and social science	3.6	1.04	0.313
		Science and Engineering	3.68	1.11	
		Art, Music, and Physical Education	3.51	0.89	
Social influence	U5	Humanities and social science	3.22	1.13	0.215
		Science and Engineering	3.19	1.12	
		Art, Music, and Physical Education	3.34	1.16	
	U6	Humanities and social science	3.36	1.09	0.486
		Science and Engineering	3.53	1.06	
		Art, Music, and Physical Education	3.43	0.92	
Behavior intention	U7	Humanities and social science	3.77	0.99	1.483
		Science and Engineering	3.94	0.95	
		Art, Music, and Physical Education	3.63	0.73	
	U8	Humanities and social science	3.81	0.96	1.795
		Science and Engineering	3.78	1.02	
		Art, Music, and Physical Education	3.46	0.78	

*p<0.05

3.4 Analysis of needs for Metaverse application in university education

3.4.1 Applicability of metaverse technology in liberal arts education and major education

The results of the survey on students' perception of applying metaverse technology to liberal arts education and major education in universities are presented in Table 8. Overall, students were positively aware of the application of metaverse technology to university education, and it was found that they were more positively aware of it in liberal arts education (80.5%) than in major education (73.1%). Furthermore, when looking at the subjective responses for specific reasons, students

recognized that the use of metaverse technology would often be unnecessary depending on the subject or characteristics of the major, and liberal arts education was more effective in providing education using metaverse technology to all students.

Table 8. Applicability of metaverse technology in liberal arts education and major education

Category	Frequency(%)	
Applicability of metaverse technology in liberal arts education	Positive	153(80.5%)
	Negative	37(19.5%)
Applicability of metaverse technology in major education	Positive	136(73.1%)
	Negative	50(26.9%)

3.4.2 Metaverse platform suitable for university education

Table 9. shows the results of students' responses that allowed duplicate selection of metaverse platform types suitable for university education. The most suitable platform was a social-based platform (35.3%), followed by a platform for online collaboration (32.2%) and a game-based platform (31.2%). In addition, there were a few opinions (1.4%) that it is necessary to develop a new platform optimized for university education rather than the existing platform.

Table 9. Perceptionof metaverse platform suitable for university education

Category	Frequency(%)	
Game-based metaverse platform	91	31.2%
Social-based metaverse platform	103	35.3%
Metaverse platform for online collaboration	94	32.2%
New metaverse platform for university education	4	1.4%
Total	292	100%

3.4.3 Importance and performance of university education using metaverse technology

The results of the IPA analysis for university education using metaverse technology are analyzed for each item as shown in Table 10. The highest level of importance was metaverse-related technology education (3.57), followed by metaverse-related basic theory education (3.53), and the use in online or blended classes (3.51). On the other hand, the lowest level of importance was found to be the use in discussion classes (3.26) and the use in lecture-style classes (3.31). The highest level of performance was its use in online or blended classes (2.83), followed by its use in team activity-oriented classes (2.78) and metaverse-related technology education (2.77). On the other hand, the lowest level of performance was utilization in lecture-style classes (2.58) and utilization in discussion classes (2.59).

Table 10. Differences in perception of the importance and performance of university education using metaverse technology

Category		Importance		Performance		t
		Mean	SD	Mean	SD	
Basic theory education	**A1**: Metaverse concept and basic theory	3.53	0.889	2.65	1.031	10.171***
	A2: Metaverse related technology education	3.57	0.928	2.77	1.038	9.254***
Curriculum-based education	**B1**: Lecture-style class	3.31	1.046	2.58	1.075	8.676***
	B2: Discussion class	3.26	1.040	2.59	1.069	8.542***
	B3: Hands-on experiment class	3.49	1.033	2.64	1.088	9.728***
	B4: Team activity-oriented class	3.49	0.974	2.78	1.061	8.708***
	B5: Online or blended class	3.51	1.038	2.83	1.109	8.143***

***p<0.001

The analysis of the IPA matrix results for university education using metaverse technology is shown in Figure 2. First of all, there are three items corresponding to the 'status quo area' (quadrant 1), which showed high levels of both importance and performance: 'metaverse-related technology education (A2)', 'use in team activity-oriented classes (B4)', 'use in online or blended classes (B5)'. Next, two items corresponding to the "priority promotion area" (2 quadrants) with high importance but low performance were found to be 'metaverse basic theory education (A1)' and 'use in hands-on experiment classes (B3)'. Next, there were two items corresponding to the 'subpriority area' (quadrant 3), which had both low importance and low performance: 'use in lecture-style classes (B1)' and 'use in discussion classes (B2).' Lastly, there appeared to be no items corresponding to 'avoiding excessive effort' (quadrant 4), which was low in importance but high in performance. In other words, it can be seen that students are demanding that education using metaverse technology be implemented most urgently in university education, including metaverse-related basic theory education and hands-on experiment classes.

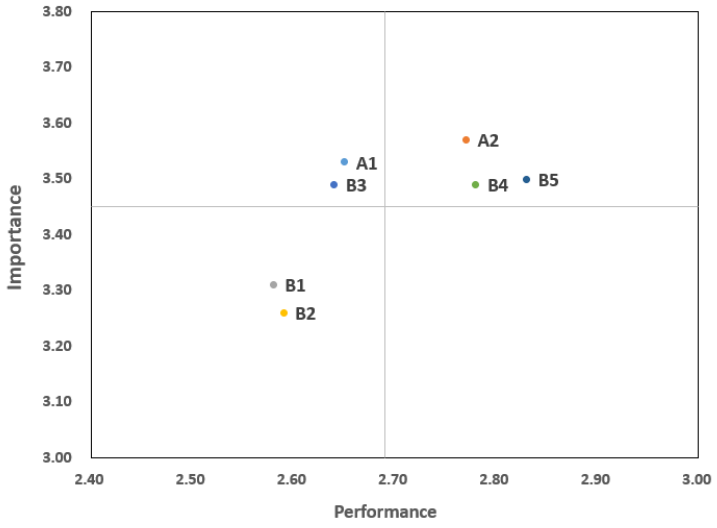

Fig. 1. IPA Matrix of university education using metaverse technology

4. Discussion and Implications

Recently, attempts have been made to utilize metaverse-related technology in university education, which allows students and professors to interact with each other and learn together even in virtual spaces (Rhee, 2021). Future university education will be able to provide new educational methods in the metaverse that were difficult to implement in existing offline education (Jin, 2021; Hong, 2021). In this study, university students' perceptions and educational needs for metaverse technology were analyzed as basic research to effectively apply metaverse-related technology in university education. The discussion and implications of the study results are as follows.

First, it was found that students used metaverse-related technology for personal needs and interests such as games, SNS, meetings, and event participation rather than as a form of education. In the recent pandemic situation, there are cases where universities used the Metaverse platform to conduct entrance ceremonies, orientations, MTs, festivals, etc., so it can be said that students' experience in using Metaverse technology was high overall. However, since students lack the experience of taking classes using the Metaverse in university curriculum, there is a need to provide various opportunities to experience and utilize the Metaverse technology in classes in the future.

Second, students in science and engineering departments were found to have a higher perception of individual innovation in metaverse technology than students in art, music and physical education departments. Therefore, it is necessary to first apply metaverse technology to science and engineering subjects, and it is necessary to design and provide various utilization strategies that can increase the interest and participation of students in art, music, and physical education, humanities and social sciences.

Third, male students expected that they would be able to acquire the necessary knowledge in university more easily if they used metaverse technology than female students, and there was a higher perception that they would take the experience of using metaverse technology for granted in the industrial sites they enter in the future. Therefore, considering the characteristics of female students who have low awareness of metaverse technology, it is necessary to develop subjects applying metaverse technology that can encompass all genders.

Fourth, it was found that students generally positively perceived the application of metaverse technology to university education, and that they perceived it more positively in liberal arts education than in major education. In previous studies, such as a study on the design and operation of university writing course lectures using the metaverse (Ahn & Heo, 2023) and a study on exploring the intention of re-use of the metaverse by students taking liberal arts computer classes (Kim, 2022), examples of classes using metaverse technology in liberal arts education were found. You can take a look. Therefore, in the future, there is a need to develop various strategies and methods to utilize metaverse technology in liberal arts education that can be easily accessed by all students regardless of major.

Lastly, as a result of analyzing the IPA matrix for university education applying Metaverse technology, the areas that need to be promoted most priority (quadrant 2) with high importance but low implementation level are 'metaverse basic theory education (A1)' and 'use in hands-on experiment

classes (B3)'. Therefore, in university education, there is a need to most urgently implement education using metaverse technology in basic theory education related to the metaverse and in experiment and practice classes. Considering the relatively high importance of 'use in online or blended classes (B5)' and 'use in team activity-oriented classes (B4)', it is necessary to develop various metaverse-related content and classes by type. Additionally, by designing a blended class that uses a mix of metaverse classes in online and offline environments, it will be possible to bring about more interaction and immersion in students.

5. Conclusions, Limitations and Future Research

In the era of the 4th Industrial Revolution, universities should attempt innovative education using metaverse-related technologies that can overcome time and space constraints and reduce the need for physical infrastructure. This study is meaningful in that it identified important information related to students' perceptions, characteristics, and needs in order to effectively apply metaverse technology to university education. Based on the results of this study, we hope to develop a variety of metaverse-using classes that can provide a sense of immersion and interest that is difficult to experience in an offline educational environment, taking into account the perceptions and characteristics of students that differ depending on major and gender. In particular, students were demanding that metaverse utilization education be provided most urgently in liberal arts education, basic theory education, and experiment and practice education. Therefore, there is a need to develop metaverse-using classes specialized for experimental and practice classes and conduct statistical effectiveness analysis through actual application research. Based on the results of this study, we plan to develop various metaverse-utilizing classes that can provide immersion and interest that are difficult to experience in offline educational environments by considering students' perceptions and characteristics that differ depending on their majors and genders.

In particular, students most urgently demanded metaverse-utilizing education in liberal arts education, basic theory education, and experimental and practical education. Therefore, it is necessary to develop metaverse-utilizing classes specialized in experimental and practical classes and conduct statistical effect analysis between the two groups for comparative analysis of the groups that applied the metaverse and those that did not through actual application research.

Meanwhile, this study analyzed the differences in metaverse-related technologies and educational needs for some learner characteristics (gender, major) with a relatively small sample size of 190 college students. The interpretation of the results of this study should be widely accepted, so it is necessary to analyze the results by considering various learner characteristics by gender, college, and major through a larger sample. Therefore, in the future, it will be necessary to present a metaverse-based teaching strategy that considers the differences according to various learner characteristics, and to conduct additional research on the factors affecting the learning outcomes of classes utilizing the metaverse.

Notes

Authorship

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No author has any other conflict of interest to declare.

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