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A Study on Metaverse Learning Based on TPACK Framework

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Abstract

In the educational environment of the post-COVID-19 era, metaverse learning, which can improve the disadvantages of online learning and improve learning outcomes, is attracting attention. Metaverse is expected to play an important role as a learning experience platform (LXP) that can provide immersion and experience for learners. In order to successfully introduce and utilize metaverse learning that utilizes the metaverse platform, teachers' knowledge of metaverse-related technologies and pedagogical convergence is important. So far, teacher knowledge for educational use of the metaverse has not been explored. In this regard, this study explored the TPACK (Technological, Pedagogical And Content Knowledge) framework as a teacher's knowledge system for metaverse learning. Based on this, this study designed the class contents of metaverse learning. The results of this study are expected to diffuse the importance of TPACK required for metaverse learning and contribute to the development of teachers' competence.

Keywords: *Metaverse, Metaverse-Learning, TPACK, LXP*

1. Introduction

The non-face-to-face society caused by COVID-19 has brought many changes to education as well as industry. Education in the post-corona era is different from before 2020. Despite the problems of online learning such as lack of communication and Zoom fatigue, students who have already become accustomed to online non-face-to-face education are uncomfortable with face-to-face classes. It is judged that the optimal learning in the post-COVID-19 era is blended learning, which is a mixture of online non-face-to-face learning and offline face-to-face learning. Therefore, there is a need for a learning method that can improve the disadvantages of existing online learning and maximize the advantages and potential.

The need for synergizing educational outcomes by introducing and utilizing the latest ICT technologies in the era of the 4th Industrial Revolution to the changed educational environment in the post-COVID-19 era is increasing. With this trend, interest in applying the metaverse to the educational world is increasing. This is because education using the metaverse platform can enhance the learning effect of learners, focusing on 'sharing' and 'communication', which are characteristics of the metaverse environment, while maintaining the

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advantages of the existing online environment [1]. In addition, the metaverse allows learners to participate in classes on their own initiative and build a variety of learning experiences. The experiences in the metaverse are not limited to virtual space, but can lead to learners' educational activities and educational experiences in the real world. In the field of education, the metaverse has developed from simply replacing offline classes (face-to-face classes), and has the potential to provide a learning experience that cannot be given in offline classes. Therefore, it is an important time to understand the metaverse as a Learning eXperience Platform (LXP) that provides new learning experiences, and to research and develop contents on the convergence of the metaverse and education.

In the post-COVID-19 era, the required capabilities of teachers are also changing. In order to effectively plan and operate blended learning, technology literacy skills, which allow teachers to design, film and develop online classes, and share developed contents with students, have become important [2]. Accordingly, interest in TPACK (Technological, Pedagogical And Content Knowledge), which is structured by adding ICT technology and tools to the teacher's knowledge system, is increasing. However, as far as we know, there has been no research on metaverse learning from the perspective of teacher competence, that is, TPACK.

This study explored TPACK for metaverse-learning, that is, learning in the metaverse environment, which is the third educational environment that combines offline and online education environments, and designed class contents based on this.

2. Related Work

2.1 Metaverse and Metaverse Learning

The metaverse is a virtual environment in which participants interact through digital objects or avatars. The metaverse is not a simple virtual environment, but a world of convergence in which the real and virtual are interconnected, and another world in which social and economic activities are possible [3]. The metaverse currently being discussed is classified as “Metaverse 2.0” [3, 4]. Metaverse 2.0 is an evolved hyper-world in which economic activities such as consumption-sales-investment, social and cultural activities of relationship-communication, expansion of reality connection, real-time, and continuity exist [3, 4]. 2020 has become the starting point of the Metaverse 2.0 era due to changes in the living environment, changes in the market, development of base technologies, diversification of content, and changes in user characteristics [3].

Metaverse is highly anticipated as a new paradigm with infinite potential as a digital space where transcendent experiences are possible [5]. Among them, interest in the application of metaverse to the educational world is increasing [6, 7]. In order to converge the metaverse platform into an educational environment, the development of optimized educational content is also emerging as an important topic. Educational content suitable for the metaverse environment should restructure the existing educational content based on the understanding of the metaverse environment, technology, and learner properties [6].

Metaverse learning is a learning type and learning activity that utilizes the metaverse platform and utilizes avatars in the metaverse in class [1].

Metaverse learning has four advantages: First, it is possible to participate more subjectively in learning activities in the virtual world through avatars that represent individual existence. Second, it is possible to implement an individualized learning process suitable for subjective learners. Third, learning activities can be specialized so that interactions occur. Fourth, gamification can be applied more smoothly than in existing education methods to improve immersion and focus on class. Gamification means applying game mechanics

and game thinking to non-game situations to engage participants and solve problems. Metaverse learning can express rules and learner data within the metaverse through leaderboards, rewards, rules, and quests. Learners can communicate and share a series of actions that occur during play. Instructors can set up and present the learning environment themselves, and create an environment where learners can enjoy fun and learning elements.

As an educational environment, the metaverse enables students to socially connect and expands students' autonomy in the learning process [2]. The educational affordance of the metaverse is not yet fully utilized.

In order to effectively integrate and utilize the metaverse in education, teacher's metaverse-related skills and pedagogical knowledge are important.

2.2 Educational Technology and Knowledge

Educational technology collectively refers to technology that combines technology with education to enhance learning effects and to support the purpose of education [8, 9]. Mishra & Koehler proposed Technological, Pedagogical And Content Knowledge (TPACK) by adding technical knowledge to the existing content knowledge and teaching knowledge (PCK) as the knowledge that teachers should have [9. 10]. TPACK is the knowledge of effective teaching using ICT applications that are appropriate in terms of pedagogy and content. As shown in Figure 1 and Table 1, TPACK consists of seven domains [11].

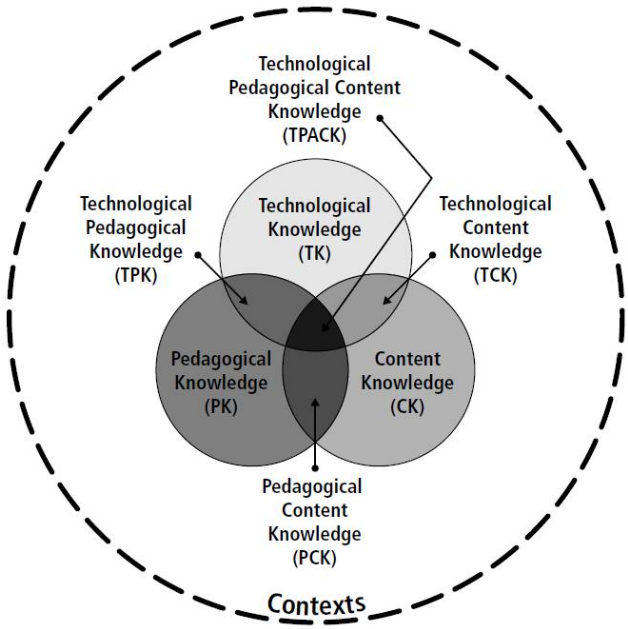


Figure 1. The technological pedagogical content knowledge framework [12]

Table 1. The 7 Areas of TPACK

Areas	contents
Content Knowledge (CK)	A teacher's knowledge of the subject matter to be learned and taught to students
Pedagogical Knowledge (PK)	A teacher's knowledge of pedagogy, educational technology, or pedagogical practice
Technology Knowledge (TK)	The teacher's knowledge of how to use the technology (softwar

	e and hardware) used in the lesson, including theory
Pedagogical Content Knowledge (PCK)	Teacher's knowledge that combines CK and PK A teacher's body of knowledge about how to present subject matter in a way that students can better understand.
Technology Content Knowledge (TCK)	Teacher's knowledge that combines CK and TK A teacher's knowledge of using technology to supplement or change existing content
Technology Pedagogical Knowledge (TPK)	Teacher's knowledge that combines PK and TK Teachers' knowledge of how to use digital tools in the classro om as a vehicle for learning outcomes and experiences.
Technology, Pedagogy and Content Knowledge (TPACK)	Comprehensive knowledge that combines PCK, TPK, and TCK Comprehensive professional knowledge, including understanding how to use technology and digital tools, and teaching methods and strategies that use them to deliver subject matter to teachers

From the teacher's point of view, TPACK develops through five stages: recognizing, accepting, adapting, exploring, and advancing [11, 12]. At the awareness stage, teachers recognize that technology can be introduced into the classroom. The acceptance stage forms positive or negative attitudes toward the teacher's integration of technology into the classroom. In the Adoption stage, teachers either adopt or reject technology into their lessons. In the exploration stage, the teacher actively introduces appropriate technology into the class. Finally, in the development stage, teachers evaluate the results of integrating technology into their lessons.

3. Exploring TPACK for Metaverse Learning

The metaverse platform-based learning in which teachers and learners are projected onto avatars can be seen as playing an educational scaffolding role in that it gives a sense of immersion at an offline level in an online class environment. In metaverse learning, which utilizes the metaverse platform, the quality of classes varies depending on the ability of the teacher who runs the class to use the metaverse [1]. In order to demonstrate the advantages and effects of metaverse learning, it is necessary to improve the ability of instructors to use the metaverse platform and related content knowledge. After the outbreak of COVID-19, the problem that emerged as the top priority in the educational field was the teacher's media literacy capability [13].

TPACK is a framework that adds Technological Knowledge to PCK (pedagogical content knowledge), a knowledge system for educators. Technological Knowledge, an area added to PCK, is summarized in Table 2 from the metaverse technology point of view.

Table 2. The TPACK areas, which is related to technology for metaverse learning

Areas	contents
Technology Knowledge (TK)	-Knowledge of metaverse types(AR, Life logging, Mirror world, Virtual worlds) -Knowledge of using the metaverse platform (Zepeto, ZEP, iflan d, Gather, ENGAGE, etc.)

	-Knowledge of using metaverse interface devices such as HMD (Head-Mounted Device), HUD (Head-up Display), VR motion s uit, and Haptic, etc
Technology Content Knowledge (TCK)	Knowledge of expressing and constructing CK using Metaverse TK and providing it to students
Technology Pedagogical Knowledge (TPK)	Knowledge of implementing teaching methods using Metaverse TK
Technology, Pedagogy and Content Knowledge (TPACK)	Balanced integration and development of {TK, TCK, TPK} into PCK Knowledge of designing, operating, and evaluating metaverse le arning

4. Class Design for Metaverse Learning

Metaverse, the learning environment of metaverse learning, is effective to be used as an auxiliary learning medium for learner-centered activities, and is suitable for Problem-Based Learning (PBL) classes that are centered on learners' activities rather than theory classes [1]. PBL is a form of small group (cohort) learning that discovers various problems that occur in life, defines them, and creatively explores ideas for self-directed problem solving. Project-Based-Learning (PjtBL), a type of PBL, is a teaching-learning method that provides a certain project or mission so that a small group (cohort) of students can cooperate to complete the project.

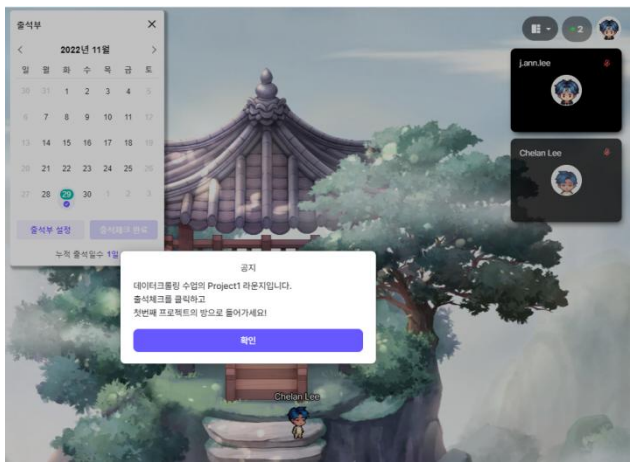
The class content designed for metaverse-learning proposed in this study is the "machine learning-based big data analysis" class. As shown in Table 3, the class consisted of (1) Pre-class, (2) In-class, and (3) Post-class. (1)In the pre-class, videos on theoretical content about the class were learned in advance on the metaverse before class. (2)In-class is mainly offline in the first half of the semester, and practice on common content is conducted in a collective training method. In the second half of the semester, the metaverse and face-to-face classes are held alternately, and the project is conducted in a cohort learning method in the metaverse space created for each group. (3)Post-class conducts peer-reviews while presenting the completed and submitted project on the metaverse.

Table 3. Class design for metaverse learning

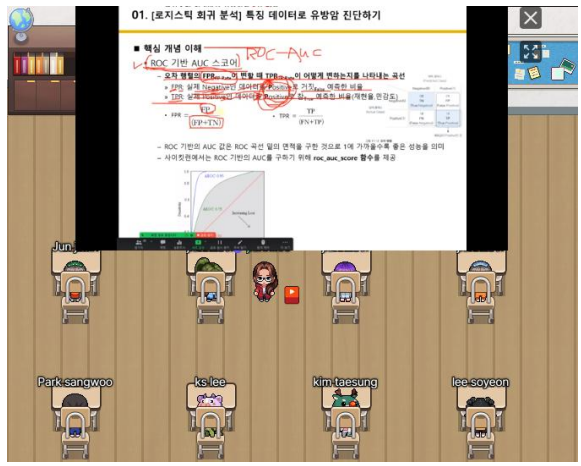
	Didactics	Class method	Learning environment	Description
Pre-class	Metaverse learning	Lecture video	Metaverse	- Watching lecture videos
In-class	Collective training	Practice of common class content	face-to-face class	- In-depth explanation of the contents of the class and conducting common practice.
	Metaverse learning On-line cohort learning	Carrying out the group project (1)	Metaverse	- Allocate a small meeting room for each group in the metaverse -The teacher visits the small meeting room to check the group project progress and provide mentoring

	Off-line cohort learning	Carrying out the group project (2)	face-to-face class	- Face-to-face group project - Check the progress of each group project face-to-face and provide mentoring
Post-class	Metaverse learning	Project presentation	Metaverse	- Presentation of projects
		Peer-review	Metaverse	- Project evaluation and feedback - Peer Review

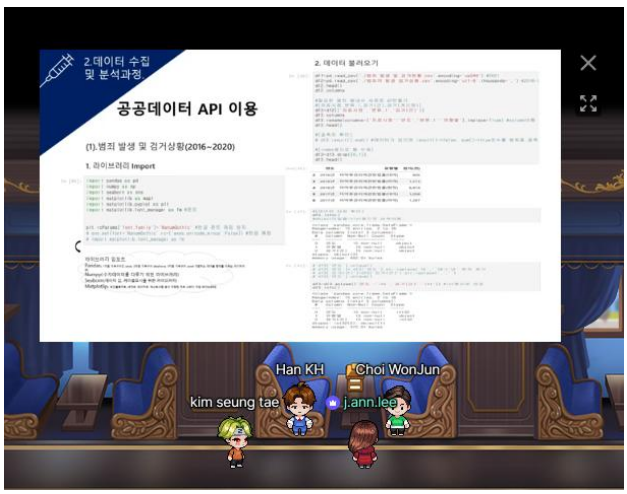
Figure 2 is pictures of the class conducted on the metaverse platform ZEP.



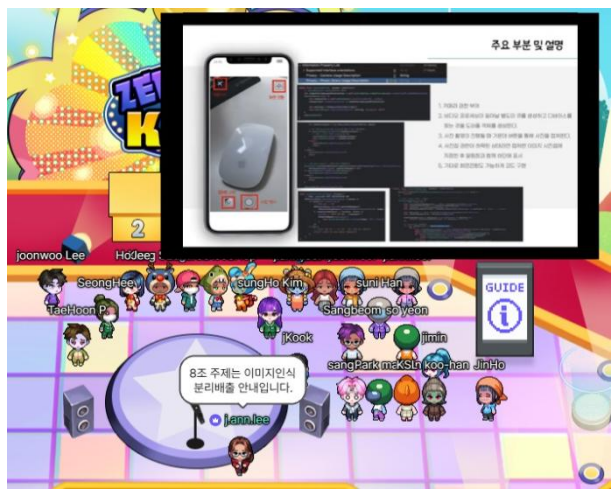
(a) attendance check



(b) pre-class



(c) In-class: Carrying out the group project



(d) Post-class: Project presentation

Figure 2. Example of a class conducted with metaverse learning

5. Conclusion

Interest in the introduction of metaverse learning is increasing as ICT technology in the era of the 4th industrial revolution and the demand for an educational environment in the post-COVID-19 era coincide. In metaverse learning, instructors and learners are projected onto 3D avatars and learn together or in groups

in the metaverse space. In order for metaverse learning to be successfully introduced and to produce educational outcomes, the instructor's metaverse competency is important. In this regard, this study examined the instructor's technological knowledge necessary for metaverse learning from the perspective of the TPACK frame. In order for instructors to implement TPACK competency for metaverse learning, rather than a separate TK competency, the metaverse TK must be integrated into PCK in a balanced way to develop TCK and TPK, and finally develop into TPACK for metaverse learning. An example of designing blended learning, which is recognized as the most suitable innovative teaching method at this point in the post-COVID-19 era, with face-to-face learning and metaverse learning was also presented. Compared to the previous semester, which was conducted with complete face-to-face and non-face-to-face classes, students' level of immersion and participation in classes was higher in the semester conducted as blended learning by applying metaverse learning. In addition, they participated in projects and presentations on their own initiative and showed an active appearance in discussions.

In future research, it is necessary to develop detailed technology (TK) for metaverse-learning to advance TPACK for metaverse-learning, and to confirm the relationship between instructor's competency and class performance through quantitative research.

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