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Paradise or Dark Side: How Does Metaverse Experience Shape the Perspectives of Pre-service Science Teachers?

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ABSTRACT

Metaverse in education has the potential to transform education by providing students with interactive, immersive and personalized learning experiences. This study examined the impact of Metaverse on the perceptions of pre-service science teachers. The study was designed in two stages. In the first stage, semi-structured preliminary interview forms were applied, and it was determined that the participants associated Metaverse with terms such as "imaginary," "virtual universe," and "expensive." Then, a comprehensive presentation was made regarding the definition, history and interdisciplinary applications of Metaverse, and the participants gained hands-on experience with 3D glasses. According to the final interview forms, it was observed that the participants evaluated Metaverse more positively in the context of "education," "communication," and "health." The study reveals that even a short-term Metaverse experience can lead to significant changes in the attitudes of pre-service teachers and develop a positive perspective towards the potential applications of this technology.

Keywords: Metaverse, opinion, pre-service science teachers, perception change, technology integration

INTRODUCTION

Metaverse has gained popularity with its ability to make digital interactions realistic (Anthes, 2022). However, important questions arise about the role of this technology in society and the ethical implications of creating a virtual world. Metaverse, which has applications in various fields, has attracted great attention thanks to technological developments (Mystakidis, 2022). Originally designed for fiction, Metaverse has become a reality thanks to advances in Virtual Reality (VR) and Augmented Reality (AR) technologies (Onu, Pradhan & Mbohwa, 2024; Damar, 2021). Positioned as the future of the Internet, Metaverse aims to provide a comprehensive and independent virtual environment for activities such as gaming, working, and socializing (Wang et al., 2023). Metaverse platform provides global connections, facilitates commercial transactions, providing education, and exchanges virtual goods using digital currencies. At the same time, it enhances learning by providing interactive and immersive experiences (Bainbridge, 2007; Castronova, 2001).

The potential of Metaverse in education stems from its ability to facilitate access to information, provide interaction in virtual environments, and offer collaborative learning experiences that are not possible in physical environments (Kapp, 2012). Particularly appealing to Generation Z, Metaverse is stated to increase student engagement and motivation by offering personalized learning experiences (Dean, 2022; Park and Kim, 2022). Using Metaverse in education increases student performance and self-confidence by providing simulated environments, specifically surgical training (Seymour et al., 2002). In language learning, VR simulations increase students' self-confidence by improving speaking and listening skills (Alwafi et al., 2022; Hoter et al., 2023). Metaverse increases motivation and engagement in a lesson or subject by providing gamified learning experiences tailored to students' needs (Caponetto et al., 2014). However, despite the positive effects of implementing Metaverse in education, there are also challenges such as high technological costs and the need for specialized technical skills (Higginns et al., 2012; Allam & Jones, 2020; Herman, 2021). Overcoming these challenges is important to realize the full potential of Metaverse in education. Various studies have revealed the necessity of increasing the potential of using innovative learning methods, encouraging users or making learning more interactive and interesting, and have developed suggestions to cope with similar problems (Allam et al., 2022; Dwivedi et al., 2022). The development of Metaverse raises concerns about social and economic inequalities. Researchers warn that Metaverse could increase existing discrimination and social prejudices (Rosioru, 2023; Sakamoto & Ono, 2024). Metaverse, which has generally been seen as a positive development in helping users socialize, has also led to increased questioning and discussion about the myriad social impacts it could have on many people around the world, as it could reshape the way we work and socialize in

many ways (Dwivedi et al., 2022). In addition, increased screen time and addiction among young users, as well as mental health problems, are also issues of concern (Przybylski & Weinstein, 2017; Kupfer, 2021). The regulatory and ethical challenges that arise with the development of Metaverse, as well as privacy and security issues arising from the collection and sharing of personal data, are also issues that require solutions (Baldé et al., 2017).

While technological developments deeply affect daily life, we are currently in the period of Metaverse, which is called the fourth wave. Metaverse aims to transform education, business, and entertainment by focusing on spatial technologies such as Augmented Reality (AR) and Virtual Reality (VR) (Friesen, 2017; Mystakidis, 2022). According to Shapiro's definition, Metaverse is a three-dimensional virtual world where real interactions are possible through avatars (Shapiro, 2021). This concept has gained great interest in the technology sector by bringing together technologies such as Blockchain, IoT, artificial intelligence, and cloud computing (Yang et al., 2022). Facebook's rebranding as "Meta" and Roblox's use of the term "Metaverse" emphasize the importance of this concept (Fennimore, 2021). Metaverse provides universal access to information by offering a new layer of social, economic, and cultural interactions (Shapiro, 2021). This virtual environment enables social, cultural, and economic interactions that are not possible in the physical environment (Ball, 2020) and facilitates interactions between humans and artificial intelligence (Wolf, 2002). Metaverse is the combination of physical reality and virtual reality, allowing digital content to interact with the physical world. Key features of virtual worlds include 3D graphical interfaces, multi-user interaction, immersion, and user-generated content (Gilbert & Forney, 2013).

Metaverse represents the development of Society 5.0 and beyond, bringing together virtual, mixed, and augmented realities by empowering virtual economies with shape and personalization (Kuş, 2021; Göçen, 2022). For Industry 5.0 and Society 5.0, which are built on human-centered manufacturing, resilience, and sustainability practices, Metaverse is currently in its infancy, but offers a variety of potential applications (Mourtzis et al., 2022; Mourtzis, 2023). “Meta” means “beyond” in Greek, and the term “Metaverse” refers to a universe that transcends reality or is beyond reality (Mystakidis, 2022). This concept represents a connected environment that enables the creation and consumption of digital products (Yang et al., 2022). In addition to its many definitions, the Metaverse reflects the common vision of a virtual universe that offers immersive and interactive experiences (Cuthbertson, 2021; Wang et al., 2021). It has taken its place in technology as an immersive digital space with its own social, economic, and cultural norms (Ritterbusch & Teichmann, 2023).

Problem Statement

While the integration of the Metaverse into education promises transformative potential, it also brings with it complex challenges that require careful and preventive assessment. As teachers explore the immersive digital possibilities of the Metaverse, it also raises issues related to equity, inclusion, and access (Kaddoura and Husseiny, 2023; Wang et al., 2022). The impact of the Metaverse on student engagement, motivation, and learning outcomes necessitates interdisciplinary research in fields such as education, technology, psychology, and sociology (Koohang et al., 2023). Ethical dimensions such as data privacy, security, and digital citizenship should be carefully examined to protect students and teachers in virtual environments (Dwivedi et al., 2022; Jamison and Glavish, 2023; Lee et al., 2024). Furthermore, potential risks such as deepening social inequalities, increasing prejudices, and spreading misinformation highlight the need for empirical research to guide responsible practices. Addressing these concerns through academic inquiry is important for shaping policies and pedagogical approaches that maximize the educational benefits of the Metaverse while reducing its challenges.

Although it is anticipated that the potential use of the Metaverse in education will contribute to development, it is stated that due to the change in technology and social conditions, the traditional teaching method is insufficient at every stage of the compulsory education curriculum for the formation of basic competencies such as social skills (Wang, 2024). In addition to the development of social skills, it has been reported that VR, called immersive experiences, will increase student participation (Holly et al., 2021). In addition, the combination of Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR) technologies and general technologies such as artificial intelligence and blockchain provide new opportunities for education that includes immersive but also tactile experiences and better connections between the real and virtual worlds (Kraus et al., 2022; Mystakidis, 2022). It is stated in the literature that the architecture in this area are not yet mature and there are many questions to be answered (Stanoevska-Slabeva, 2022). Considering that the use of technologies such as the Metaverse in education will become inevitable, it is important to determine the current perceptions and attitudes of candidate science teachers on this subject. Similar studies are available in literature and support the positive potential of the Metaverse in education. However, we have not come across studies in which experiences and opinions are processed together in the literature on the Metaverse (Akpınar, Kuloğlu, & Erdamar, 2022; Demirel & Köroğlu, 2024; Drigas, Chaidi, & Papoutsi, 2023; Durukan, 2023; Hwang et al., 2024; Thohir et al., 2023). However, the literature suggests that the reason for this is that the Metaverse has an interdisciplinary approach, economic factors, and technical infrastructure (López-Belmonte et al., 2023; Stanoevska-Slabeva, 2022). In the

study conducted with pre-service science teachers who had no previous Metaverse experience, a 1-hour training module was first presented and then all pre-service science teachers were given the opportunity to try Metaverse universe. After this process, the changing perceptions, attitudes and opinions of the pre-service science teachers were examined. In this context, two different opinion forms were applied to pre-service science teachers: before the training experience and after it. In this regard, answers were sought to the following research questions:

RQ1: What are the views of prospective teachers who have not had any previous experience with Metaverse?

RQ1.1: What are the views of prospective teachers on the concepts they associate with Metaverse?

RQ1.2: What are the views of prospective teachers on the use of Metaverse and its future?

RQ2: After experiencing Metaverse, what do prospective teachers think about;

RQ2.1: What are the views of prospective teachers on the concepts they associate with Metaverse?

RQ2.2: What are the views of prospective teachers on the use of Metaverse and its future?

RQ3: What changes do pre-service science teachers experience physically and emotionally during their Metaverse experience?

RESEARCH METHOD

The research used a qualitative research method, which has an individual-focused approach that deeply examines the experiences, perceptions, attitudes, behaviors and beliefs of society and people, allows for the comparison of the processes and dynamics that form the basis of a causal relationship and the examination of social, cultural and physical contextual factors (Given, 2021). Metaverse technology is a very new innovation and many aspects of it have not yet been investigated. Many studies are ongoing, not only in terms of perception but also in terms of its physical effects and its effects on ethical values. The physical or mental effects of Metaverse and similar technologies, which have been used specifically in the field of education, on humans are not yet known. For this reason, since we do not have sufficient information about the use of Metaverse technology in educational processes, we conducted our research with a phenomenological design that reveals the individual's perception and understanding of a phenomenon or experience (Mertens, 2023). In addition, we have formulated our research questions in this direction. In terms of science education and researching the potential effects of the Metaverse, we examined the opinions of science teacher candidates on the subject with the qualitative approach used to deeply examine the data obtained as a result of experiencing the Metaverse.

Participants

The study collected qualitative data through an interview form administered to pre-service science teachers, capturing their perspectives on Metaverse before and after their experience. The research focused on pre-service science teachers at the 1st, 2nd, 3rd and 4th grade levels at the faculty of education of a university located in the west of Turkey, who were selected using typical case sampling, one of the purposeful sampling methods (Patton, 1987; Creswell, 2021).

All pre-service science teachers who participated in the study were participants who had not participated in a program such as technology education, digital design, or computer courses. All participants included in the study were pre-service science teachers who had taken a first-year "Information Technologies" course. This approach was chosen to include participants who had not previously experienced Metaverse, allowing the study to observe changes in perceptions after exposure to this technology. To ensure diversity, participants were selected considering factors like gender, and educational background. Out of 55 prospective teachers initially involved, 6 were excluded due to prior Metaverse experience, leaving 49 participants (Table 1). Although these participants were aware of Metaverse technology through media, none had direct experience with it (Tashakkori & Teddlie, 2010).

Table 1: Participants and their demographics

Demographic Variables	Gender				Total	
	Male		Female			
Grade Level	f	%	f	%	f	%
1st Grade	8	32,0	7	29,2	15	30,6
2nd Grade	5	20,0	6	25,0	11	22,4
3rd Grade	7	28,0	4	16,7	11	22,4
4th Grade	5	20,0	7	29,2	12	24,5
Total	25	100,0	24	100,0	49	100,0

Data Collection, Tools and Analysis

The entire data collection process was carried out through Voluntary Consent and Google Drive Form. No audio or video recordings were taken from the participants, only the responses to the form were collected online. Data collection involved a Voluntary Consent Form, four demographic questions (name, gender, and grade level), and three interview forms. The first interview form, addressing Metaverse, included four questions: one set before and another set after the

experience. The final interview form, administered post-experience, had two questions focusing on physical and mental changes experienced by participants. Voluntary consent was obtained separately for each form. The interview questions were organized into themes and applied sequentially. Given the novelty of Metaverse and limited research, the study examined participants' associations, potential benefits, harms, and the physical and mental effects of the experience descriptively. The forms were reviewed by 12 experts (measurement and evaluation specialists, science teachers, computer teachers, a computer engineer, and an AI engineer) for thematic coherence, clarity, and simplicity using Lawshe's (1975) technique. The minimum Content Validity Ratio (CVR) was set at 0.56, and CVRs were calculated accordingly. Since no questions fell below the KGOmin threshold, no revisions or removals were made to the interview forms. After ensuring content validity through expert feedback, the forms were finalized for use before and after Metaverse experience.

The study process was explained to the participants in detail. Before the Metaverse experience, interview form was applied. With this form, opinions were collected from participants who had never experienced Metaverse before. Following this, a 30-minute presentation provided an overview of the Metaverse and discussed its definition, history, uses, and possible benefits and harms. After the informative presentation about Metaverse, participants discovered that they individually chose from 20 pre-designed Metaverse environments, each for 20-25 minutes. After the Metaverse experience, participants filled out the second interview form, which evaluated physical and mental changes.

To facilitate data collection, all forms were converted to QR codes, accessible via Google Drive links. Data from the forms were analyzed using MAXQDA software, generating themes, codes, tables, and visual representations (Yıldırım & Şimşek, 2021). Pre-service science teachers were anonymized with codes like *TC1*, *TC2*, *TC3*, etc., to enhance reliability. MAXQDA facilitated a detailed analysis of participants' perceptions of Metaverse, enabling the identification of patterns and models. The study was further analyzed using MAXQDA, providing in-depth insights. There are several limitations in the study that associates the concept of Metaverse with pre-service science teachers who constitute the sample of the research. These are data collection from a sample consisting of a single region, university and department, sample size, research approach and method used, research questions sought to be answered, conceptual limitations, budget and time constraints, lack of literature, use of technology, environmental and social limitations.

RESULTS

The responses to the research questions determined within the scope of the study by the 49 participants who agreed to participate in the study through the Voluntary Consent Text are given in order. The interview forms completed by the pre-service science teachers with no previous Metaverse experience before their presentation and experiences and their answers to the sub-research questions (*RQ1*, *RQ2* and *RQ3*) were examined.

Findings Regarding Pre-Experience Views in Research

This part of the research includes the findings obtained from the views of science pre-service science teachers regarding the concept of Metaverse within the scope of RQ1. In this stage of the research, Metaverse experience of the participants who had never experienced Metaverse before and their views before the presentation were included. In addition, the most frequently used words were examined after removing suffixes, prepositions, and conjunctions from the data obtained from pre-service science teachers in the MAXQDA analyses. In this first stage, where the prospective teachers' views on the concepts they associate with Metaverse and their views on the use and future of Metaverse are investigated, their responses to the questions in the interview form within the scope of RQ1 are given under the relevant headings, respectively.

Findings Regarding the First Sub-Research Question Before the Experience of Research

At this stage of the research, when the most frequently used words were examined from the data obtained from the question "What does the concept of Metaverse mean to you? Please provide brief information" asked to the prospective teachers in the MAXQDA analyses, a total of 5 key concepts were obtained, namely Environmental Perception (27), Economic Dimension (42), Reality Perception (16), Emotional State (38) and Future Views (35) (Appendix Figure 1). Some of the explanations of the prospective teachers are as follows:

TC5: "…I think it's the technology of the future and the main media environment, but it's not a real world and that scares me a little bit…"

TC18: "…I am currently undecided about its usefulness because it is expensive and no one has enough knowledge of the subject, but I think it can be adapted and used in every environment in the future…"

TC20: "…It's a different and new technology, but since I've never experienced it, it seems far from reality to me…"

TC33: "…I see a technology that most people cannot access due to cost…"

Findings Regarding the Second Sub-Research Question of Research Before Experience

At this stage of the research, when the most frequently used words were examined from the data obtained from the question "Can you write 5 words that you associate with the concept of Metaverse?" directed to the prospective teachers in the MAXQDA analyses, a total of 11 key concepts were obtained, namely Current Life Interest (17), Visual (12), Education (3), Security (34), Economy (41), Emotion (38), Augmented Reality (14), Virtual Reality (16), Mixed Reality (2), Universe (44) and Technology (39) (Appendix Figure 2). Some statements of pre-service science teachers are as follows:

TC1: "Universe, Science, Technology, Innovation"

TC8: "Digitalization, Virtual World, Artificial Intelligence, New Generation Technology"

TC14: "Avatar, Experience, Movie, Game"

TC15: "Reality, Technology, Asociality, Getting Away from Real Life"

TC29: "Virtual Universe, Character, VR Glasses, Cryptocurrency, World"

TC45: "Virtual Universe, Avatar, Film, Economy"

TC48: "Virtual World, VR Glasses, Crypto"

Findings Regarding the Third Sub-Research Question of Research Before Experience

At this stage of the research, when the most frequently used words were examined from the data obtained from the question "Do you think Metaverse is useful? Briefly explain why" asked to prospective teachers in the MAXQDA analyses; a total of 3 key concepts were obtained, namely I am undecided/not sure (41), Emotional State (18) and Security (5) (Appendix Figure 3). Below are some statements of pre-service science teachers:

TC3: "It may be possible depending on the intended use, but I'm not sure."

TC10: "It could be very useful, I'm not sure."

TC27: "It may do more harm than good, I'm undecided."

TC31: "It gives us an incredible chance to perform our scary, dangerous etc. actions."

TC39: "It can be very scary for some people, but it can be used to address or resolve these fears."

TC46: "I think it would be beneficial if clear security was provided for our personal data."

Findings Regarding the Fourth Sub-Research Question of Research Before Experience

At this stage of the research, when the most frequently used words were examined from the data obtained from the question "Do you think Metaverse is harmful? Briefly explain why" asked the prospective teachers in the MAXQDA analyses; A total of 5 key concepts were obtained, namely I am undecided/not sure (41), Security (14), Health (5), Sociality (2) and Perception of Reality (1) (Appendix Figure 4). Some statements made by pre-service science teachers are as follows:

TC2: "It is harmful because it can cause alienation from the real world."

TC6: "Like any technology, it can also be used for malicious purposes. The risk of addiction is high. "

TC7: "I don't think it's harmful, it just needs to be a little more reliable."

TC19: "It can be harmful for individuals who are on the verge of being disconnected from social life at the level of addiction or for asocial individuals. However, I think it will be the opposite for individuals with a wide social circle. I cannot give a definitive answer."

TC26: "I think it can be harmful if used for a long time because I think it emits radiation and rays around."

TC37: "I think it could be harmful because it could negatively affect our social relationships, but I'm not sure."

TC40: "I think it might be harmful because it might affect my eye health."

TC42: "I think spending time in another universe can harm us psychologically."

TC47: "I am worried about our personal data."

TC49: "It is as harmful as other technologies."

Findings Regarding Post-Experience Opinions in Research

This part of the research includes the findings obtained from the views of science pre-service science teachers regarding the concept of Metaverse within the scope of RQ2. At this stage, Metaverse experience of participants who have never experienced Metaverse and their views after the presentation are included in the scope of the research. In addition, at this stage of the research, the most frequently used words were examined after removing suffixes, prepositions, conjunctions, etc. from the data obtained from pre-service science teachers in MAXQDA analyses. In this first stage, where the prospective teachers' views on the concepts they associate with Metaverse and their views on the use and future of Metaverse are investigated, their responses to the questions in the interview form within the scope of RQ2 are given under the relevant headings, respectively.

Findings Regarding the First Sub-Research Question of Research After Experience

At this stage of the research, when the most frequently used words were examined from the data obtained from the question "What does the concept of Metaverse mean to you? Please provide brief information" asked to the prospective teachers in the MAXQDA analysis, a total of 6 key concepts were obtained, namely Education (32), Perception of Environment (37), Economic Dimension (24), Perception of Reality (43), Emotional State (28) and Future Views (15) (Appendix Figure 5). Some of the statements of pre-service science teachers are as follows:

TC4: "I can say that it is an interesting experience, it transforms learning into a form that will arouse curiosity."

TC15: "I think that there is a virtual universe that makes it possible to do things that are difficult to do in real life or that are feared and unwanted and makes it easier to cope with them."

TC23: "Like living a life in another world and in our dreams."

TC29: "I think it can be an intriguing educational environment for students."

TC31: "I was very worried but I was extremely happy and excited so I think it is a fun technology."

TC36: "Training in Metaverse can improve our collaboration skills, for example, working with people from different cultures."

TC40: "Being in Metaverse made learning like playing a game, which could help me gain knowledge without getting bored."

TC42: "Educational materials can become more engaging in the virtual environment."

TC44: "Opportunity to put theoretical knowledge into practice with real-time applications"

TC45: "I see it as a timeless and spaceless technology."

TC47: "Sometimes it's hard for me to speak in front of people, so I think avatars can help me overcome this, so Metaverse can be very useful for me."

TC49: "I think it is a perfect area of discovery, open to new experiences and an unlimited learning area."

Findings Regarding the First Sub-Research Question of Research After Experience

At this stage of the research, when the most frequently used words were examined from the data obtained from the question "Can you write 5 words that you associate with the concept of Metaverse?" directed to the prospective teachers in the MAXQDA analyses; Innovation (4), Virtual Activities (11), Society (7), Current Life Interest (39), Entertainment (18), Education (44), Visual (19), Security (12),

Emotion (25), Economy (16), Virtual Reality (39), Augmented Reality (32), Mixed Reality (24), Universe (45) and Technology (41), a total of 15 key concepts were obtained (Appendix Figure 6). Some of the statements made by pre-service science teachers are as follows:

TC3: "Digital Education, Virtual Meetings, Interactive Lessons, Virtual Stores, Virtual Events"

TC8: "Virtual Economy, Digital World, Education Technology, 3D Education, Virtual Collaboration"

TC17: "Digital Assets, Virtual Exhibition, Interactive Learning, Virtual Tours, Digital Art"

TC21: "Virtual Offices, Educational Simulations, Digital Connection, Virtual Campus, Creative Projects"

TC33: "Virtual Communities, Educational Tools, Digital Economy, Digital Games, VR Glasses"

TC38: "Social Networking, Digital Art, Virtual Events, Innovative Learning, Virtual Store"

TC41: "Artificial Intelligence, Blockchain, Markets, Identity, Virtual World"

TC46: "Interaction, Virtual Lessons, Hologram, Digital Campus, Exploration"

TC48: "Education, Global Access, Interactivity, Security, Virtual Laboratory"

Findings Regarding the Second Sub-Research Question of Research After Experience

At this stage of the research, when the most frequently used words were examined from the data obtained from the question "Do you think Metaverse is useful? Briefly explain why?" asked to the prospective teachers in the MAXQDA analyses; Interaction (19), Self-confidence (17), Change of Opinion (45), Unlimited Access (28), Meeting/Interview (28), Design (8), Student-Teacher Interaction (32), Game (15), Travel (9), Art (5), Language Learning (2), Individual Learning (24), Disabled Individuals (18), Education (47), Potential Benefit (4), Security (16), Purpose of Use (38) and Emotional State (33), a total of 18 key concepts were obtained (Appendix Figure 7). Some of the statements made by pre-service science teachers are as follows:

TC4: "I think it will be very useful with proper use."

TC7: "When adapted correctly, it will make learning interesting and engaging."

TC11: "I think that the benefit or harm of this application depends on us who apply it. The purpose for which we use this application will be quite decisive."

TC16: "It is definitely beneficial, a new world and unlimited potential"

TC19: "I was skeptical at first, but virtual lessons in Metaverse really accelerated my learning process."

TC21: "Metaverse even brought new job opportunities to my mind. I don't think it will be harmful; I think it is a very useful technology."

TC25: "I can have a fascinating and exciting experience with my students in a timeless and spaceless environment. This can increase my students' interest and motivation in the lesson."

TC32: "At first, I thought it could be harmful, but thanks to the experience my perspective has changed a lot. I can go to all the countries that I could not go to due to economic, time etc. reasons. I can realize everything I want to see and experience."

TC36: "I think it is a great technology. Before I tried it, my perspective was different and I thought it could be useful, but I didn't know in which areas it would be useful. Thanks to my experience, I gained a whole different perspective."

TC38: "I was very impressed by the ease and accessibility for disabled individuals. I also have disabled acquaintances in my family and close circle. I will encourage them to experience it too."

TC39: "I think it is useful. It provides many advantages such as virtual meetings and the opportunity to interact with people from different countries."

TC42: "I was skeptical at first, but I think virtual theater shows will offer a new learning experience by combining art and education. It will bring people together, regardless of their profession, and shape our hobbies."

TC45: "At first I thought Metaverse might have its downsides, but my virtual experience was relaxing and rewarding."

TC48: "It is definitely useful! Virtual laboratories and interactive lessons will be very effective in education. I also think that it will positively affect my communication with my teachers or educators in every subject."

Findings Regarding the Third Sub-Research Question of Research After Experience

At this stage of the research, when the most frequently used words were examined from the data obtained from the question "Do you think Metaverse is harmful? Briefly explain why?" asked to prospective teachers in the MAXQDA analyses, a total of 5 key concepts were obtained: Harmlessness (41), Security (28), Health (33), Sociality (21) and Perception of Reality (44) (Appendix Figure 8). Some statements made by pre-service science teachers are given below:

TC3: "At first I thought it would be harmful, but after experience I think it is a harmless technology."

TC8: "We can prepare lessons according to students' personal learning times. I think there are many benefits like this. I don't think there would be many harms."

TC11: "I think it mostly affects our sociality, other than that I don't think it's harmful."

TC17: "It is a platform where we can improve ourselves and do more, but it can also have its disadvantages. For example, the protection of personal data. Maybe this can be resolved with legal regulations."

TC29: "It may lead to the end of today's business and may cause economic losses, but it also has so many economic benefits that it can be tolerated."

TC42: "I can't even think of the harms compared to the benefits."

TC45: "I don't think it's harmful in terms of education, but it may cause psychological harm when people use it for a long time."

Findings Regarding Views on Experiential Physical and Mental Changes in the Study

This part of the research includes the findings obtained from the views of science pre-service science teachers regarding the concept of Metaverse within the scope of RQ3. At this stage, Metaverse experience of participants who have never experienced Metaverse and their views after the presentation are included in the scope of the research. In addition, at this stage of the research, the most frequently used words were examined after removing suffixes, prepositions, conjunctions, etc. from the data obtained from pre-service science teachers in MAXQDA analyses.

In this first stage, where the prospective teachers' views on the concepts they associate with Metaverse and their views on the use and future of Metaverse are investigated, their responses to the questions in the interview form within the scope of RQ3 are given under the relevant headings, respectively.

Findings Regarding the First Sub-Research Question of Research on Experiential Physical and Mental Changes

At this stage of the research, when the most frequently used words were examined from the data obtained from the question "Can you tell us about the time you spent and your experiences in Metaverse?" directed to the prospective teachers in the MAXQDA analyses, a total of 13 key concepts were obtained, namely Technology (37), Disabled Individuals (3), Education (42), Sports Activities (16), Adaptation to Real Life (24), Adaptation to the Virtual Universe (9), Perception of the Environment (45), Exploration (11), Emotional State (Negative) (4), Emotional State (Positive) (45), Perception of Reality (39), Daily Life Interest (18) and Adventure (2) (Appendix Figure 9). Some information provided by pre-service science teachers is as follows:

TC2: "I attended a virtual meeting for 15 minutes. It was great to meet people from different countries."

TC4: "I spent 15 minutes in Metaverse and participated in a virtual sports event. Everything was so realistic."

TC7: "I took a virtual trip for 10 minutes; it was very exciting to explore different parts of the world."

TC11: "I participated in a virtual dance party for 15 minutes. It was really fun. I can't wait to do it again."

TC16: "I attended a virtual art workshop for 10 minutes. It was great fun to create works of art in a virtual universe."

TC19: "I spent 15 minutes in Metaverse and worked in a virtual science lab. The experiments were very interesting."

TC25: "I spent 5-10 minutes. I can say that wandering around the universe and the feeling of reality is intriguing and interesting."

TC32: "I spent 15 minutes in the universe, and it was an amazing experience. It was exciting and my concept of reality changed."

TC36: "I felt very strange when I first tried it. Because I had never used it before. While using it, I felt like I was in real life for a moment, but it tries to materialize a different, abstract life in front of your eyes. It was a nice experience for me."

TC42: "I experienced it for the first time, at first, tasks came to me in the application, I tried to do them, then I came across stairs, and I was thinking of going up the stairs, then I thought I was in the virtual world and gave up doing it. It was like I was teleported to a different world from real life, when I took off my glasses, I felt strange at first, I felt like I was in a void, it was a perfect experience for me."

TC48: "It was a different and beautiful experience that changed our perception of reality. The kind of environment you would always want to be in."

Findings Regarding the First Sub-Research Question of Research on Experiential Physical and Mental Changes

The second question of the interview form applied in the last stage of the research covers the physical and mental changes experienced by the prospective teachers while they were in Metaverse universe or afterwards regarding their experiences with Metaverse. In this context, information was collected about various situations related to the sense of vision, dizziness, nausea or adaptation. In this direction, it was determined that most of the participants who tried Metaverse for the first time for an average of 10 minutes did not experience symptoms such as vision loss, blurred vision/dizziness/nausea. Some of the participants stated that they had complaints of short-term blurred vision (2) and dizziness (5). However, they stated that they thought these symptoms could also be due to excitement (T2, T7, T31). In some of the responses, it was determined that they were worried that they could experience similar symptoms in long-term use. Most of the participants stated that

they did not have any problems adapting to real life (T1, T8, T48). However, some participants stated that they felt a difference in their perceptions for a few seconds. Nevertheless, they stated that even a very short experience was enough to observe its effects. Some of the explanations of the prospective teachers regarding the question covering physical and mental changes in terms of experience in the interview form are as follows:

TC2: "I didn't experience any dizziness as my experience was short but it was strange when stepping on the ground."

TC3: "I haven't experienced it, it feels weird but I haven't experienced any physical condition."

TC6: "Yes, I experienced this, it was a small 2-3 second blackout and dizziness."

TC8: "I haven't had any problems since I haven't used it for a long time."

TC13: "I had blurred vision for a very short time and felt like I was changing size."

TC17: "I haven't had any problems since I haven't used it for a long time."

TC19: "I didn't experience nausea but I felt really bad."

TC22: "I had trouble realizing where I was for a few seconds."

TC31: "At first there is a feeling of confusion and not understanding where you are. Then you adapt."

TC37: "It felt strange and odd to return to normal life visually."

TC40: "I lived, it was like waking up from a three-dimensional dream."

TC45: "I didn't have too much difficulty because I didn't use it for too long. However, I think that if we apply it too much, we will have adaptation problems at some points when returning to real life."

TC48: "Since I didn't spend much time there, I didn't have much trouble adapting."

DISCUSSION AND CONCLUSIONS

Discussion

Metaverse, popular for its realistic digital interactions, raises ethical and social concerns despite its potential in fields like gaming, education, and commerce (Anthes, 2022; Damar, 2021). In education, Metaverse facilitates access to information and offers collaborative, personalized learning experiences, especially appealing to Generation Z (Kapp, 2012; Dean, 2022; Park & Kim, 2022). However, high costs and technical demands hinder its application (Higgins et al., 2012; Allam & Jones, 2020; Herman, 2021). Concerns about increased social inequalities, screen addiction, and mental health impacts are also prominent,

alongside data privacy and security risks (Przybylski & Weinstein, 2017; Kupfer, 2021; Baldé et al., 2017).

This study examines the perceptions of pre-service science teachers with no prior Metaverse experience. Participants received training and experienced virtual environments, and their changing perceptions were analyzed using MAXQDA. Initially, participants were hesitant, associating Metaverse with uncertainty, but after the experience, they viewed it more positively as an educational tool. Concepts like education, technology, and interaction became more prominent, though concerns remained about its potential harms, such as addiction and isolation. Participants generally found the experience positive, with minimal physical discomfort. Pre-experience findings highlighted themes like environmental perception, economic aspects, and skepticism, with many participants undecided about Metaverse's usefulness and compatibility with reality. After experiencing Metaverse, pre-service science teachers gained a more positive perspective, especially regarding its educational applications. Key concepts that emerged included Education, Perception of Reality, and Emotional State. Participants highlighted Metaverse as an engaging, effective learning tool, describing it as fun and exciting. Initially, they held mixed feelings and viewed Metaverse as an expensive and potentially harmful technology. However, after the experience, they recognized its potential in education, associating it with concepts like technology, virtual reality, and interaction.

Pre-service science teachers initially struggled to relate Metaverse to specific concepts, but after the experience, they could identify relevant connections and associated it with multiple disciplines. Those who initially saw Metaverse as merely imaginative or inaccessible shifted to seeing it as a viable educational tool. Concerns about economic, physical, and mental risks, including data privacy and socialization issues, remained, but participants suggested that legal regulations and limited usage could mitigate these harms. They emphasized Metaverse's potential in education, particularly in activities like virtual experiments, museum visits, and interactive learning materials. Overall, the study observed a significant shift toward more positive views on the benefits of Metaverse, particularly in education, while concerns about its harmful aspects decreased. Similarly, in MacCallum and Parsons' (2019) article, which included both in-service and pre-service science teachers and examined their attitudes towards the implementation of AR, participants were given the opportunity to experience Metaverse. Participants experienced mobile AR using Metaverse AR tool and sought answers regarding its educational potential. One of the most important outcomes of this study was that it revealed that AR tools led to new ideas in in-service teachers about how they could be applied in education, but generating these new ideas required a degree of experience that pre-service science teachers did not have. In a study conducted by Hwang, Lee, and Jeon (2024) in which pre-service English teachers designed and used their own customized chatbots in the context of Metaverse field, the

participants' perceptions of their experiences with course design and teaching demonstrations were examined. In this study, it was determined that Metaverse played an important role in the participants' learning processes. In addition, the importance of technology use for teacher education programs was emphasized in the study, and it was stated that combining different technologies would provide pedagogical benefits to teachers and positively support their professional development.

Conclusion

Metaverse has become a significant part of contemporary culture, especially among younger generations, by transforming their socialization and entertainment habits. Its interactive nature, which allows for hedonic experiences and is easily accessible through mobile devices, has broadened its user base and enriched experiences. Despite its growing presence, there is limited research on the long-term effects of Metaverse on young users and its implications in educational settings. Current studies, such as those by Lee & Gu (2022) and Xu et al. (2023), highlight the need for more in-depth exploration of how Metaverse can be integrated into education and the perceptions of young people toward this new virtual world. Research by Semerci et al. (2024) concluded that incorporating Metaverse technology into education could enhance the learning process, increase student motivation, and positively impact academic performance. Similarly, Dwivedi et al. (2022) argued that educational institutions must adopt innovative teaching methods to address the evolving needs of students, especially in the wake of global crises like the COVID-19 pandemic, which exposed the limitations of traditional education. Technologies like augmented reality, virtual reality, and Metaverse have been recognized for their potential to introduce a new paradigm in education, making learning more interactive and engaging. According to Hasenzahl et al. (2022), these technologies help students grasp abstract concepts better, foster complex problem-solving skills, and encourage active participation in collaborative environments. Metaverse is a rapidly advancing technological domain that offers unique experiences by blurring the boundaries between the physical and virtual worlds. Scholars like Mystakidis (2022) suggest that the limitless possibilities of Metaverse could fundamentally transform human experiences. However, this development comes with ethical, security, and social concerns, as well as risks of physical and mental health issues (Dick, 2021). As Metaverse expands and introduces new innovations, these concerns become more prominent, highlighting the need for a comprehensive examination by policymakers, teachers, and families to address potential harms, regulatory gaps, and ethical dilemmas.

In the light of the data collected in the study, it is revealed how the views of the prospective teachers towards Metaverse are affected after a short-term and

single experience. Data were obtained indicating that the virtual universes that the prospective teachers participating in the study found exciting, fascinating or surreal directly affected their attitudes and motivations thanks to the potential benefits they contained. In addition, a study conducted to determine the difficulties, potential and value associated with Metaverse showed that technical and social difficulties hinder the ability to cope with user-related and organizational difficulties (Schöbel, & Tingelhoff, 2023). However, one of the outcomes of our study shows the opposite. For example, it was determined that a prospective teacher who had difficulty speaking in front of the public and another prospective teacher who had difficulty expressing himself/herself stated that he/she thought that the speeches or presentations he/she made while in the virtual universe could be more fluent and comfortable. In addition, educational institutions should take steps to facilitate students' adaptation to Metaverse technology. These steps include providing students with training on using this technology and facilitating the use of the technology. In addition, it is important for teachers to have the necessary skills to use Metaverse effectively (Akyürek, et al., 2024). In addition to these skills, moral and ethical behaviors should be subject to legal sanctions. In addition, various trainings can be recommended for possible physical and mental problems. The data obtained within the scope of the research also support these views. The fact that the negative views of pre-service science teachers who have never experienced the virtual universe before changed after the experience and the majority of them touched on ethical and moral problems also reveals concerns.

SUGGESTIONS

This research shows that Metaverse has significant potential in the field of education. However, more research is needed on the long-term effects and potential risks of this technology. The study shows that more research and application are needed on the use of Metaverse in education. In addition, the security issues of Metaverse should be studied and the protection of users' personal data should be ensured. More detailed studies should be conducted on the psychological effects of long-term Metaverse use and courses on new technologies such as Metaverse should be added to teacher training programs. However, while this study is associating the Metaverse concept with pre-service science teachers, it has certain limitations such as being limited to a university in a single region, small sample size, limitations of the research approach and method, budget and time constraints, lack of literature, use of technology, and environmental and social factors, which can be considered as a starting point to distinguish between potential risks and benefits and can provide direction and ideas for new studies. In addition, the presence of sufficient studies in literature for these and similar risks can provide serious precautions against the difficulties to be encountered in education. Similarly, to see its potential benefits, studies covering a wide area and with large

and diverse sample groups will provide the opportunity to evaluate and criticize the Metaverse phenomenon in education from different aspects. It is desired to obtain more data on the use of Metaverse technology in education and to conduct in-depth studies. For this reason, it is recommended that initiatives be made for teachers of different ages, branches, genders, fields of study and schools. In addition to its potential benefits, Lee et al. (2024) have expressed significant concerns about the potential harmful effects of Metaverse. These concerns include problems such as data security breaches, harassment of users, exposure to harmful content and addiction. Studies, especially on young children, have shown that Metaverse environment is not safe due to many factors such as sexual abuse and addiction (CCDH, 2024). For this reason, much more extensive studies should be conducted on Metaverse. Metaverse research should be conducted simultaneously and at different times in different cultures. Another study by Statista (2021) stated that Metaverse can lead to addiction, privacy, and mental health problems. The precautions that need to be taken should be carried out cautiously and correctly, from the government makers to the family, which is one of the smallest units. Necessary precautions and developments can be provided by examining both the negative and positive legal and sociological effects in detail. In addition, while students use the Metaverse in academic terms and at every educational stage, their mastery of concepts such as personal data, cyber security, etc. can be strengthened while observing the sociological, physiological and psychological effects. This situation shows that urgent measures should be taken to regulate Metaverse and protect users.

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