



# 원격수업 도구로서 마인크래프트 활용 교수 경험 분석

## A Qualitative Analysis of K-12 Teaching Experiences Using Minecraft as a Remote Instruction Tool

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### 요약

코로나19 팬데믹 기간 동안 마인크래프트는 게임 플랫폼을 넘어 학습자의 교육 경험을 확장하는 메타버스 기반 학습 환경으로 활용되었다. 본 연구는 원격수업 환경에서 마인크래프트를 교수·학습 도구로 활용한 초·중등 교사의 교수 경험을 분석하는 것을 목적으로 한다. 이를 위해 마인크래프트 활용 수업 경험이 풍부한 초·중등 교사 7명을 대상으로 질적 연구를 수행하였다. 연구 결과, 마인크래프트는 교실을 확장하는 디지털 학습 공간으로서 학습자 주도의 탐구를 촉진하고 원격수업 상황에서도 학습의 연속성을 지원하는 것으로 나타났다. 교사들은 디지털 트윈 구축, 스토리텔링 기반 탐구 설계, NPC를 활용한 단계적 안내와 개별화된 스캐폴딩, 그리고 외부 에듀테크 도구와의 결합을 통해 학습자의 상호작용과 협력을 강화하였다. 한편, 디지털 게임 환경에 대한 교사의 낮은 숙련도, 플랫폼 기능의 제약, 교육과정과의 정합성 확보의 어려움 등 구조적·실천적 한계도 함께 제기되었으며, 이는 제도 및 전문성 개발 지원의 필요성을 시사한다. 본 연구는 마인크래프트를 활용한 수업 설계에 대한 실천적 시사점을 제공한다.

**주제어** 마인크래프트, 원격수업, 교수경험, 초·중등학교, 질적연구

### ABSTRACT

During the COVID-19 pandemic, Minecraft evolved from a gaming platform into a metaverse-based environment that expanded learners' educational experiences. This study explores the teaching experiences of K-12 teachers who used Minecraft as an instructional tool in remote learning contexts. A qualitative study was conducted with 7 K-12 teachers with extensive experience integrating Minecraft into their instruction. The findings indicate that Minecraft provided an expanded digital learning space that supported learner-driven exploration and educational continuity in remote settings. Teachers employed pedagogical strategies such as digital twin construction, storytelling-based inquiry, and NPC-supported scaffolding, often integrating external EdTech tools to enhance interaction and collaboration. However, several challenges were identified, including limited teacher familiarity with game-based environments, platform functional constraints, and difficulties with curriculum alignment, highlighting the need for institutional and professional support. These findings offer practical insights into designing engaging and meaningful instruction using Minecraft.

**Keywords** Minecraft, Remote Instruction, Teaching Experience, K-12, Qualitative Research

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## 1. Introduction

The COVID-19 pandemic has brought about rapid changes in global education, with the widespread adoption and normalization of remote learning as a central shift[1]. Particularly, since 2020, many countries, including South Korea, have transitioned to remote learning as the primary mode of instruction in K-12 education. This change has served as not only a response to an immediate crisis but also an opportunity to explore the potential of remote learning as an alternative instructional model that overcomes the spatiotemporal limitations of in-person learning[2]. In Korea, following the pandemic, instructional forms such as blended learning and flipped learning have been widely adopted in schools[3]. More recently, the establishment of online schools to support elective courses tailored to high school students' career paths and interests has further reinforced the institutional framework of remote learning[4]. As the policy foundation for remote learning has expanded, demand has been increasing for effective instruction strategies and instructional tools that maximize learning outcomes in remote environments[5]. In particular, the focus has shifted toward tools and strategies that can engage learners and facilitate interaction beyond simple knowledge transmission, emerging as key tasks for improving the quality of remote education.

Minecraft can effectively promote immersion and interaction in remote learning environments. As an open-world sandbox game, Minecraft enables users to freely build and explore digital worlds, offering an immersive and engaging learning experience[6]. Before the pandemic, Minecraft was primarily regarded as an educational tool for game-based learning. However, following the widespread adoption of remote learning since the pandemic, it has increasingly been reimagined as a metaverse-based educational platform that extends the physical classroom into a virtual environment[6]. In this virtual environment, physically separated learners can continue to engage in social interactions and community experiences, expanding the scope and significance of Minecraft as a learning platform. In this study, the metaverse is defined not merely as a three-dimensional virtual space but as a digital ecosystem in which multiple users participate

concurrently through avatars, engage in social practices such as interaction, collaboration, and creation within a persistent shared world, and expand experiences and meanings through user-generated content. The core components of the metaverse are a shared 3D space, avatar-based social interaction, connectivity-based collective activities, and world-building and scalability enabled by user-generated content. Given that Minecraft operationalizes these elements in educational contexts, it can be conceptualized beyond a simple game tool as a metaverse-based learning platform[7].

This transformation has been particularly significant in addressing the educational challenges of maintaining engagement, collaboration, and interaction in remote learning. Several universities worldwide, unable to hold physical graduation ceremonies due to COVID-19, organized online graduation ceremonies in a Minecraft-based virtual campus designed by students. Similarly, some universities have created virtual campuses to conduct various classes for first-year students[8]. In K-12 education, Minecraft has been integrated into lessons where students explore historical landmarks, visualize mathematical concepts through spatial structures, and apply coding and automation principles[9]. Since the pandemic, Minecraft has continued to be used in remote and blended learning environments, with growing interest in instruction strategies that enhance learning outcomes.

Research has shown that Minecraft can improve students' creativity, spatial awareness, digital literacy, and collaboration skills across various educational levels, from elementary to higher education[10, 11]. While earlier studies primarily focused on students' responses, cognitive achievements, and attitudinal changes, more recent research has increasingly explored teachers' instructional design and implementation experiences[9, 12]. However, research that deeply investigates teachers' experiences using Minecraft as a tool for remote instruction within a metaverse-based learning environment remains limited. In particular, research analyzing teachers' experiences of reconstructing learning spaces in virtual environments, designing learner participation, and facilitating interactions with digital tools is crucial to improving the educational effectiveness of game-based remote instruction. Therefore, exploring the

real-world instruction experiences of educators during the pandemic provides valuable insights into the educational value and limitations of Minecraft as a remote learning tool.

Prior game-based learning research has primarily focused on how game mechanics can enhance learners' motivation, engagement, and achievement. However, with the widespread adoption of remote instruction following the COVID-19 pandemic, Minecraft has been increasingly re-conceptualized not merely as an educational game but as a metaverse platform that enables the construction and sharing of learning spaces, avatar-mediated interaction, and user-generated activities. From this perspective, it is important to recognize that teachers' roles extend beyond simply using a game to designing learning worlds and orchestrating interactions as learning-experience designers. Accordingly, this study seeks to re-examine the educational potential of digital tools for remote instruction through teachers' practical experiences and to derive future directions and practical implications for metaverse-enabled teaching and learning.

## 2. Literature Review

### 2.1 Educational value of Minecraft

Minecraft is an open-world sandbox game that allows learners to freely build, explore, and collaborate in a virtual environment. Unlike traditional educational methods, this characteristic enables inquiry-based learning, problem-solving activities, and collaborative project execution, making it suitable for student-centered lesson designs[11, 13]. Specifically, Minecraft: Education Edition integrates various educational elements, including curriculum-linked content and coding features, enhancing its applicability in school settings[10]. Additionally, it can be used across a range of subjects, including history, English, geography, and STEM[9].

The educational value of Minecraft can be summarized as follows. First, Minecraft enhances educational effectiveness by fostering immersion and a sense of realism. The game's inherent interactivity and high level of user autonomy help learners actively engage in lessons. Additionally, the excitement, challenges, and immediate

feedback the game offers sustain learners' attention and participation, thereby fostering sustained immersion and self-directed learning behaviors[14]. These immersive learning experiences not only support learners' affective attitudes but also enhance practical problem-solving skills and transferable thinking, making them highly valuable in educational contexts.

Second, Minecraft promotes collaboration and interaction among learners. While working toward shared goals, learners collaboratively design structures or solve problems, negotiating meaning and engaging in real-time peer communication. Accountability and the distribution of roles are emphasized during group activities, while collaborative feedback deepens understanding and improves collective output. Furthermore, learners experience social interaction by sharing their creations[11].

Third, Minecraft enhances learners' agency[15]. Activities within Minecraft allow learners to actively explore the virtual world, manipulate environments, and solve problems through their avatars. This allows learners to be passive recipients of knowledge and active agents who design and explore learning situations, thereby strengthening their self-directed learning capabilities[16].

Fourth, Minecraft facilitates conceptual learning through simulation. For instance, in mathematics, students apply concepts such as symmetry, ratio, and area through construction activities. In contrast, subjects such as social studies and music allow for the visualization and experience of historical contexts or traditional cultural elements within the virtual space. These activities help learners apply and internalize theoretical concepts in practical and simulated environments.

Fifth, Minecraft can promote learning outcomes through immersive experiences. Learners explore, create, and experiment as avatars in a 3D virtual environment, developing a sense of presence within the learning world, which can enhance task focus, learning persistence, and engagement in learner-driven inquiry[17]. In particular, when instructional design elements such as storytelling, quests, digital twins, and NPC-based scaffolding are integrated, immersion can extend beyond mere enjoyment into a learning experience that strengthens concept application, problem-solving, and the quality of collaborative knowledge construction.

Finally, Minecraft-based instruction aligns with the 2022 revised curriculum by integrating key competencies such as creative problem-solving, collaboration, and digital literacy through authentic tasks. Learners experience performance connected to real-world contexts beyond the classroom by modeling, reproducing, and validating concepts in digital spaces. In addition, Minecraft's open-ended creation environment promotes collaborative meaning-making and cooperative problem-solving grounded in constructivist and sociocultural perspectives on learning. In this respect, Minecraft can be conceptualized beyond a simple educational game or content-delivery tool as a metaverse-based learning platform in which learners co-design, create, and interact around shared spaces and tasks. In sum, Minecraft extends beyond conventional game-based tools by enabling immersive, collaborative, and learner-driven educational experiences. Its potential for facilitating conceptual learning, fostering problem-solving, and supporting student agency makes it a valuable resource across various subjects.

## 2.2 Minecraft as a remote learning tool

Following the COVID-19 pandemic, remote learning became widespread, prompting the educational community to recognize the need for immersive digital environments that foster learner participation and interaction. In this context, Minecraft has gained attention as a metaverse-based learning platform capable of hosting courses in virtual spaces, extending its function beyond traditional game-based learning. By incorporating core elements of the metaverse—such as avatar-based interaction, shared space construction, and real-time collaboration—Minecraft offers a viable alternative to overcome the physical and psychological constraints of remote learning. Particularly during the pandemic, remote learning using Minecraft positively impacted learning outcomes and played a significant role in mitigating students' feelings of social isolation[18].

During the pandemic, various educational initiatives utilizing Minecraft demonstrated its potential as a remote learning tool. One approach involved attempting to increase learners' immersion and motivation by building digital twins of real-world environments. A digital twin is a virtual representation of a physical place that mirrors

key features of the real-world environment for exploration, simulation, and learning. The pandemic prevented students from visiting familiar places, so teachers recreated everyday environments in the virtual world and engaged students in learning activities. For instance, students at an elementary school in South Korea engaged in a social studies lesson focused on "Our Community" during the pandemic[19]. Teachers recreated key local landmarks, cultural heritage sites, and public institutions within Minecraft. Students visited these virtual places to engage in various expressive activities, which positively influenced academic achievement and learning attitudes. Similarly, in Brazil, elementary schools utilized Minecraft in geography lessons[20]. Students digitally recreated their local areas or ancient cities, designing and implementing core geographical concepts, including map-making, orientation, scale, and symbols. Collaborating in teams, students constructed terrain and solved problems independently, improving their spatial awareness and geographic imagination while deepening their understanding of real-world spaces in a virtual environment. These digital twin-based activities serve as reality-based simulations that enable learners to reproduce and transform real-world spaces in virtual environments while engaging in iterative inquiry.

A second approach involved designing "quests" that encouraged students to take initiative in solving problems. This strategy constructs simulation-scenario-based inquiry activities by presenting problem situations that integrate goals, constraints, and feedback, thereby helping learners refine their solution strategies through repeated attempts and revisions. In doing so, it enables learners to explore and construct knowledge rather than passively receive information. During the pandemic, elementary schools in Japan developed quests of varying difficulty, which students solved using Minecraft's programming tools[21]. Students went through multiple attempts and revisions to devise solutions, thereby enhancing their problem-solving skills through iterative exploration.

A third approach focused on promoting interaction in remote environments, where direct interaction between teachers and students, as well as among students, is limited. Teachers suggested collaborative tasks that required students to

work together and communicate. Additionally, they provided step-by-step scaffolding through non-player characters (NPCs) in avatar-based environments to maintain the learning flow and facilitate learner interactions. NPCs are computer-controlled characters embedded in the virtual world that can deliver prompts, guidance, or feedback to support learners' progress. For example, Marrara et al [22] built a "Physics Park" in Minecraft for teaching physics concepts remotely, where NPCs guided the learners and provided experimental explanations. Students collaborated on tasks in a virtual laboratory, repeatedly conducting experiments using Minecarts to investigate acceleration, sharing ideas, and solving problems together. This design effectively fostered interaction and immersion beyond simple knowledge transmission, even in remote environments.

Despite these benefits, teachers and students may encounter difficulties utilizing Minecraft for remote learning. First, Minecraft has limitations in fully supporting the wide range of teaching and learning activities required for remote education. The basic chat feature is often insufficient for detailed communication or immediate feedback, prompting teachers to frequently use external real-time video conferencing tools such as Microsoft Teams or Zoom [20]. Additionally, Minecraft lacks comprehensive features for systematically collecting and analyzing student attendance, activity records, and individual task logs, making it difficult for teachers to monitor and intervene in students' learning progress in real time. This limitation can lead to structural challenges in managing the quality of assessments and providing feedback, particularly in project-based learning that require formative assessments and self-directed learning checks.

Second, the lack of proficiency with digital tools among both teachers and students can hinder the effective use of Minecraft in remote classrooms. Students unfamiliar with Minecraft may struggle with basic operations, navigating the interface, and using command blocks [23]. Moreover, many teachers lack the technical skills, instructional design expertise, and platform management capabilities necessary for effective implementation, making it difficult for them to address technical issues or respond to student requests promptly [24]. Consequently, the burden on teachers increases,

ultimately affecting the sustainability and scalability of Minecraft-based lessons.

Third, Minecraft-based education entails issues of equity and accessibility. School-level differences in hardware performance, network quality, and overall infrastructure directly affect the adoption of Minecraft lessons and students' sustained participation. In addition, in remote learning contexts, disparities in household device ownership and internet access can influence learners' engagement and performance; thus, even when schools provide the same instruction, students' actual learning experiences may vary considerably [25].

Fourth, Minecraft-based education can impose a substantial instructional design burden on teachers. When teachers lack sufficient technical understanding, designing and implementing lessons can become particularly challenging. As a result, some teachers tend to rely on pre-made resources rather than creating or modifying materials themselves, or they simplify activities, which may ultimately constrain the more profound learning experiences that Minecraft can support.

Fifth, Minecraft-based education may raise concerns about excessive immersion. While Minecraft's open world, reward structures, and creation- and exploration-centered activities can effectively enhance learners' interest and engagement, there is a risk that students may focus too heavily on in-game activities rather than instructional goals or experience difficulties regulating their learning time.

### 3. Method

#### 3.1 Participants

This study involved a total of seven in-service teachers currently working in South Korea: four elementary school teachers and three secondary school teachers. All participants had conducted Minecraft-integrated lessons consistently for more than one year and had prior experience engaging in educational projects, research initiatives, or authoring publications related to Minecraft-based instruction. To ensure the relevance of their experiences to the study's purpose—examining the pedagogical implications of using Minecraft as a metaverse platform in remote instruction—the researchers provided a detailed

explanation of the study objectives and obtained informed consent from each participant. The final participant pool consisted of the seven teachers who voluntarily agreed to participate in the study. The demographic and professional characteristics of the participants are summarized in Table 1.

**Table 1.** Participant characteristics

Part.	Gender	Position	Subject	Yrs. Exp.
A	Male	Elementary	All	20
B	Male	Elementary	All	15
C	Male	Elementary	All	10
D	Male	Elementary	All	16
E	Female	Middle	Computer Science	11
F	Male	Middle	Korean	6
G	Female	Middle	English	9

### 3.2 Data collection and analysis

In this study, data were collected through in-depth online interviews conducted via Zoom in October 2022 with in-service teachers who had prior experience integrating Minecraft into their instructional practice. Each participant took part in a single 90-minute interview session facilitated by one to three researchers. To encourage thoughtful reflection, a semi-structured interview guide was emailed to the participants one week prior to the interview. With informed consent, all interviews were audio-recorded and transcribed verbatim for analysis. The interview questions were designed to allow participants to freely articulate their perceptions of Minecraft-based teaching practices while remaining aligned with the study's central themes. Topics included reasons for adopting Minecraft as a metaverse platform, instructional strategies used during lessons, perceived learning outcomes, and challenges encountered throughout the teaching process. The transcribed data were analyzed using qualitative content analysis, a method that identifies recurring patterns and core concepts within textual data and organizes them into categories. This approach is well-suited for exploring the characteristics and perceptions of specific populations[26]. This approach was deemed appropriate for analyzing the educational features of Minecraft-integrated instruction and teachers' perspectives on its instructional value. The specific interview questions are presented in Table 2.

The data analysis followed a three-step coding procedure based on Strauss and Corbin's[27] grounded theory methodology: open coding, axial coding, and selective coding. In the open coding phase, researchers carefully reviewed the transcripts multiple times to extract key statements and assign initial conceptual labels (e.g., "spatial expansion," "immersion," "interaction," and "digital twin"). During axial coding, conceptually related codes were grouped into higher-order categories. For example, codes such as "game elements," "accessibility," "interest," and "learning motivation" were organized under the broader category of "enhancing student motivation through game-based learning." Finally, in the selective coding phase, the researchers identified core categories that reflected the study's research questions and objectives. This process resulted in the emergence of four key categories: (1) educational rationales for using Minecraft, (2) instructional strategies employed in Minecraft-based lessons, (3) perceived educational outcomes, and (4) instructional challenges encountered when using Minecraft.

**Table 2.** Interview questions

Part.	Yrs. Exp.
Educational Rationale	<ul style="list-style-type: none"> <li>· What motivated you to begin using Minecraft for educational purposes?</li> <li>· Why did you choose Minecraft among various platforms?</li> <li>· What is the purpose of Minecraft-based education?</li> <li>· What do you expect to achieve through Minecraft-based education?</li> <li>· What are representative examples of Minecraft-based education?</li> </ul>
Instructional Strategies	<ul style="list-style-type: none"> <li>· How do you reconstruct the curriculum in Minecraft-based lessons?</li> <li>· What teaching and learning methods do you prefer in Minecraft-based lessons, and why?</li> <li>· What types of learning tasks do you typically present in Minecraft-based lessons?</li> <li>· How do you use avatars (characters), objects, and NPCs in Minecraft-based lessons?</li> <li>· Which EdTech tools do you integrate with Minecraft, and why?</li> <li>· What other factors should be considered for Minecraft-based lessons?</li> <li>· What preparation is needed to implement Minecraft-based lessons?</li> <li>· Are there any established rules that should be followed to ensure smooth Minecraft lessons?</li> <li>· What problems occurred when the lesson rules were not followed?</li> </ul>
Educational Effects	<ul style="list-style-type: none"> <li>· What positive or negative changes or effects were observed in students?</li> <li>· What positive or negative changes or effects were observed in teachers?</li> <li>· What were the responses of others (e.g., administrators, fellow teachers, parents)?</li> </ul>
Educational Challenges	<ul style="list-style-type: none"> <li>· What are the challenges of Minecraft-based lessons?</li> <li>· What efforts did you make to overcome these challenges?</li> </ul>

### 3.3 Reliability and Validity

To enhance the reliability and validity of the analysis results, several strategies were employed. First, a member-checking procedure was conducted to verify the accuracy of the data analysis. The findings were shared with the participants, who reviewed and confirmed whether the interpretations appropriately reflected their experiences and perspectives. Second, triangulation was applied by utilizing supplementary materials such as lesson plans, instructional resources, and student-created artifacts provided by the teachers. These additional data sources were used to validate the consistency and credibility of the interview responses. Third, two researchers independently reviewed the coding and analysis processes to ensure inter-rater reliability and maintain logical coherence and consistency in interpretations. Inter-coder agreement was  $k = .92$ . Any discrepancies in coding were discussed and resolved collaboratively throughout the analysis process. Finally, a constant comparison method was used to repeatedly compare the interview data and related materials against the emerging categories. This iterative process enabled the researchers to refine and confirm the appropriateness and relevance of the research question categories. The coding results are presented in Table 3.

Table 3. Coding results

Core Category	Upper Category	Kye Codes
Educational Reasons	Expanding Digital Learning Spaces Beyond the Physical Classroom	expansion of spatial and temporal constraints, expansion of the physical classroom, digital educational space, problem-solving experiences in a digital space
	Facilitating Learner-Centered Inquiry in an Immersive Virtual Environment	immersion, engagement, promotion of curiosity and inquiry, 3D virtual environment, virtual experiences for real-world application, cultivation of comprehensive learning competencies
	Enhancing Student Motivation through Game-Based Learning	the engaging elements of games, inducing learning participation and strengthening motivation to participate, promoting interaction

Core Category	Upper Category	Kye Codes
Instructional Strategies	Real-World-Connected Learning through Digital Twin	digital twin, real-world problem-solving experiences, facilitating understanding of the real world, expanding opportunities for collaborative communication
	Immersive Lesson Design through Storytelling	storytelling-based lesson design, leveraging minecraft's storytelling and creative features, implementing learning content through storytelling, providing engaging learning experiences, active participation in the storyline
	Immersive Lesson Design through Storytelling	storytelling-based lesson design, leveraging minecraft's storytelling and creative features, implementing learning content through storytelling, providing engaging learning experiences, active participation in the storyline
	Learning Guidance and Scaffolding through NPCs	NPC, learning guidance, scaffolding, providing learning information, enhancing learning understanding, opportunities for self-directed learning, immediate feedback, assistant teacher
	Enhancing Learning Outcomes through Integration with Other EdTech Tools	integration with edtech tools, concurrent use of multiple platforms, promoting interaction, expanding learning experiences
	Promoting Peer Communication and Collaborative Learning	collaborative communication experiences, assigning co-creation-centered tasks, digital communication spaces, collaborative learning competencies
Educational Effects	Improvement in Active Communication and Collaborative Problem-Solving Skills	active communication, dynamic mutual interaction, collaborative problem solving, teachers as collaborators and facilitators, communication competencies
	Enhancement of Learners' self-directed learning and Active Participation	interest, self-initiated participation, participation-centered instruction, learner agency
	Promotion of Creative Output through a High Degree of Freedom	high degree of freedom, active communication experiences, production of creative outputs, refinement of thinking, enhancing creativity and analytical skills
	Increased Sense of Achievement and Satisfaction with the Learning Experience	achievement, positive feedback, instructional efficacy, building self-esteem, class satisfaction

Core Category	Upper Category	Kye Codes
Challenges in Implementing	Limited Teacher Proficiency in Minecraft and Pedagogical Design	minecraft operation skills, pedagogical strategies, metaverse operating principles, digital tool manipulation skills
	Concerns About the Gap in Student Engagement Between Minecraft and Non-Minecraft Lessons	gap in learning interest, gap between minecraft-based lessons and regular classroom instruction
	Limitations of Minecraft's Educational Features	platform functional limitations, constraints of the education edition
	Insufficient Budget for Licensing and Operational Support	securing licenses, budget shortages

## 4. Results

### 4.1 Educational Reasons for using Minecraft

#### 4.1.1 Expanding Digital Learning Spaces Beyond the Physical Classroom

Teachers perceived Minecraft as a metaverse-based educational tool that enabled the expansion of learning spaces from the physically limited classroom to a more flexible and innovative digital environment. During the COVID-19 pandemic, several teachers reported conducting homeroom sessions and school announcements using Minecraft. Students were allowed to freely access the virtual school environment constructed within Minecraft even after school hours and on weekends, thereby continuing school-related activities beyond traditional temporal and spatial constraints.

In some cases, students engaged with key learning content at home through Minecraft. They later participated in collaborative planning or group discussions at school, effectively blending home and school learning environments through a shared digital space. This practice reflected an intentional shift from the physical classroom to a digital twin of the school environment. Notably, teachers expected that problem-solving experiences within the metaverse could enhance students' real-world problem-solving competencies. These

findings suggest that Minecraft can serve not only as an extension of physical space but also as a transformative learning and community-building environment that transcends temporal and spatial limitations.

*During the remote learning period, we used to gather during homeroom time to hold class meetings. As part of a student-led club, we had a Metaverse Club, where students built a virtual version of Sejong Middle School's campus. On weekends or after school, the kids could log in freely, play games together, or join escape room games and treasure hunts that they had created themselves. (Teacher F interview)*

#### 4.1.2 Facilitating Learner-Centered Inquiry in an Immersive Virtual Environment

Teachers recognized that the spatial appeal of Minecraft's 3D virtual world plays a crucial role in fostering learner-centered inquiry by enhancing students' immersion and engagement. They viewed the visually rich and interactive environment of Minecraft as a catalyst for student curiosity and exploration, enabling them to engage with learning tasks in ways that felt personally meaningful. Teachers reported that students could access, explore, communicate, and solve problems within the virtual space according to their preferences, resulting in highly immersive and individualized learning experiences. Notably, teachers emphasized the pedagogical value of using Minecraft to provide virtual experiences in which students apply conceptual knowledge to solve real-life problems. Such experiences were perceived as promoting knowledge transfer and strengthening comprehensive learning competencies, including systematic thinking, self-expression, idea generation, and problem-solving skills.

*With 3D environments, the space itself is so engaging that you don't need any extra tools to motivate the kids. They just get completely immersed on their own. The kids are pretty good at solving math problems about perimeter and area, but I've always wondered whether that knowledge transfers to real learning. In Minecraft, when they build something, it's not just about putting up structures—you have to divide and assign real estate first, like zoning out the land before construction. That kind of layer adds*

*depth to the learning. (Teacher C interview)*

#### 4.1.3 Enhancing Student Motivation through Game-Based Learning

Teachers utilized the intrinsic appeal of games as a motivational strategy to promote student engagement, particularly noting that many students were initially introduced to Minecraft as a game rather than an educational tool. Recognizing this familiarity, teachers intentionally integrated the engaging elements of Minecraft into their instructional design to stimulate active participation. Given that Minecraft is widely recognized and enjoyed by students, teachers reported that learners could navigate and interact with the platform independently without requiring detailed instructions. This familiarity allowed students to participate in learning activities without the typical resistance or anxiety often associated with academic tasks. As a result, students became immersed in classroom activities without consciously perceiving them as formal lessons. Moreover, teachers observed that students who were generally passive in traditional learning environments displayed heightened motivation and active involvement when using Minecraft. These students not only leveraged their gaming skills but also engaged collaboratively with peers, enhancing their communication and social interaction. Such experiences led teachers to view game-based learning tools like Minecraft as highly effective in increasing student motivation and fostering meaningful engagement, ultimately supporting the development of diverse academic competencies.

*Even students who are usually quiet, introverted, or not academically strong—if they're good at games, they can shine in this virtual world. I've seen them take the lead and even guide the high-achieving students through planning and designing lessons together. That kind of collaborative learning, where every student's strengths come out and develop evenly, made me realize that games like this can truly be powerful educational tools. (Teacher G interview)*

## 4.2 Instructional Strategies for Using Minecraft

### 4.2.1 Real-World-Connected Learning through

### Digital Twin

Teachers designed digital twins within Minecraft and used them to present authentic problem scenarios. These digital spaces allowed students to simulate, experiment with, and engage in hands-on learning activities that would otherwise be difficult to access or visualize in the physical classroom. The primary instructional intent was to help students experience the complexities of the real world in a three-dimensional format and to encourage them to express their ideas in response to those scenarios freely. Teachers emphasized that this approach not only enhanced students' abilities to articulate and share their thoughts but also deepened their understanding of real-world issues through interactive engagement with virtual environments. Notably, projects that involved transforming or creatively reconstructing real-world settings within the digital twin environment helped students develop a contextual and practical understanding of those settings. These activities also fostered creativity, encouraging learners to generate innovative solutions aimed at addressing real-world challenges. Furthermore, by situating such activities in a remote learning context, the use of digital twins promoted increased opportunities for collaborative communication and engagement among students.

*The final goal for the students was to recreate our school inside Minecraft—to replicate the real school as accurately as possible. It was very much a project-based learning experience with a clear purpose. The kids were super motivated—they were racing to finish, even running outside during class to take pictures of the school. They'd bring back those photos and focus on recreating everything in detail. It was impressive to see how dedicated they were to making it as realistic as possible. (Teacher E interview)*

### 4.2.2 Immersive Lesson Design through Storytelling

To enhance student engagement and immersion, teachers designed lessons incorporating storytelling elements. They purposefully leveraged the affordances of Minecraft to create diverse narrative experiences within its virtual environment. Affordances refer to the actionable possibilities a tool or environment offers to users, shaped by the

interplay between its features and users' goals and perceptions. By embedding instructional content into story-based scenarios, teachers encouraged students to understand concepts as if they were part of an unfolding narrative. This approach enabled students to collaboratively explore and resolve emergent problems, thereby supporting the development of problem-solving and creative thinking skills. The use of storytelling facilitated learners' intrinsic motivation, allowing them to internalize and reinterpret the content in a more meaningful way. This storytelling-based instructional design was implemented across various subjects, including science, history, and language arts. Teachers reported high levels of instructional satisfaction when using this strategy, noting that Minecraft's 3D virtual world allowed students to vividly experience and recreate text-based narratives. Within these story-driven environments, students were encouraged to actively navigate problem situations and generate solutions, which proved to be a key factor in promoting deep, immersive learning.

*In our ecosystem lesson, students explored a virtual elephant village and discovered problems on their own. They realized, "Oh, the elephants are losing their habitat and coming into the village." It's like uncovering the storyline of a game, but it's not something I explicitly told them. The story is embedded in the Minecraft world itself. (Teacher D interview)*

#### 4.2.3 Learning Guidance and Scaffolding through NPCs

Teachers actively utilized NPCs to provide instructional guidance and scaffolding within the Minecraft learning environment. NPCs played a critical role in delivering essential information, supporting learning objectives, and checking student understanding. Teachers reported that NPCs were particularly helpful in enabling students to manage their learning processes more autonomously and efficiently. Beyond serving as simple in-game characters, NPCs were strategically employed as virtual teaching assistants that guided learners through tasks, offered supplemental information, and provided instructional cues in the absence of the teacher. This approach provided students with

opportunities for self-directed learning, allowing them to independently seek out and interpret information relevant to their tasks. Moreover, NPCs provided immediate feedback, enabling students to assess and improve their understanding in real-time. Such uses of NPCs contributed to the development of learners' self-assessment skills. They promoted metacognitive engagement by allowing them to monitor and regulate their learning based on personalized interactions within the virtual environment.

*I usually post tasks or assignments through NPCs or on a bulletin board, so students don't have to keep messaging me to ask what they need to do. Instead, they can just ask the NPC and get the answer. I set it up so the NPC can respond with the instructions when students interact with it. I also make announcements like, "If you talk to this NPC, it'll tell you what you need to do." It's a simple way to guide them without direct interaction. (Teacher A interview)*

#### 4.2.4 Enhancing Learning Outcomes through Integration with Other EdTech Tools

Teachers recognized the functional limitations of Minecraft in supporting diverse educational needs, such as managing learning records and facilitating rich interactions among students. To address these constraints and expand the learning impact, they integrated Minecraft with other educational technologies. In particular, teachers frequently utilized platforms such as Microsoft Teams, Zoom, and YouTube in conjunction with Minecraft to compensate for the game's limited voice communication features and to provide supplementary learning materials. For example, learners used Microsoft Teams to talk in real time about their tasks and collaboratively solve project challenges. Teachers also leveraged tools such as Padlet to encourage students to articulate, share, and compare their conceptual understandings. Teachers emphasized that this integration created a synergistic effect by combining Minecraft's shared immersive space with real-time communication and coordination tools. They perceived that the use of Teams or Zoom alongside Minecraft not only reduced interaction barriers but also strengthened peer collaboration through immediate discussion,

role negotiation, and collective decision-making during project tasks. By combining the strengths of these platforms, teachers were able to foster more meaningful interactions among learners, deepen students' understanding of the subject matter, and create a more enriched and multifaceted learning experience. This multi-platform integration significantly extended the educational affordances of Minecraft and enhanced its effectiveness as a tool for remote and blended learning.

*Since students can't talk to each other or communicate using voice in Minecraft itself, the only option is to use something like Teams or Zoom at the same time. (Teacher B interview)*

#### 4.2.5 Promoting Peer Communication and Collaborative Learning

Teachers actively employed strategies to encourage peer communication and collaboration, guiding students to solve problems through cooperative efforts within the Minecraft environment. Students were assigned construction-based tasks that were difficult to complete individually, requiring them to exchange ideas, coordinate roles, and work toward a common goal. To facilitate this, teachers often created dedicated communication spaces within Minecraft, enabling collaborative activities that could not be completed within the physical classroom or during regular class hours. Notably, teachers observed a positive phenomenon of mutual support among students: advanced learners frequently assisted those who struggled, and reciprocal peer teaching—often referred to as “mutual learning” or “peer scaffolding”—emerged organically.

These experiences suggest that the Minecraft environment offers a dynamic and engaging communication setting that fosters collaboration more effectively than traditional face-to-face classrooms. They also highlight the platform's potential to cultivate students' collaborative learning competencies through increased interaction, mutual assistance, and shared responsibility.

*With Minecraft, I found that as long as the teacher explains just a few basic things, peer learning naturally starts to happen. If there are students who*

*know the platform well, they help those who are struggling, and they support each other in a kind of give-and-take system. That kind of collaboration seems to happen much more actively. (Teacher A interview)*

### 4.3 Educational Effects of Using Minecraft in Instruction

#### 4.3.1. Improvement in Active Communication and Collaborative Problem-Solving Skills

Instruction using Minecraft was found to be effective in shifting classroom dynamics away from traditional, passive models centered on reading and listening toward more active, learner-centered approaches emphasizing speaking and writing. This shift enhanced communication between teachers and students, as well as among students themselves. Teachers reported that their instructional identity transformed from that of an authoritative instructor to that of a facilitator or collaborator, actively engaging with students to navigate new and unfamiliar problem scenarios. Compared to face-to-face classes—where a single teacher may struggle to provide timely feedback or individualized support to many students—Minecraft-based classes allowed learners to take greater initiative. Students independently searched the internet for information and communicated through in-game chat or voice platforms, fostering mutual support. These activities served not only as mechanisms for collaborative problem-solving but also as opportunities for developing more advanced communication and language skills through authentic and contextualized use.

*In Minecraft, if they get stuck, they can just look things up on YouTube, chat with friends, ask me questions, or search on Google. They realize they can find the information they need and express it in English however they want. I think that helped them become more willing to use English actively. That was probably the most successful part of it. (Teacher G interview)*

In traditional offline classroom settings, teachers have identified social exclusion among learners as a significant factor that negatively affects various aspects of school life. Teachers often encounter

difficulties in engaging marginalized or slower learners in classroom activities. However, they observed that Minecraft-based instruction helps address such challenges by leveraging a familiar game-based environment, which lowers learners' resistance and anxiety toward learning tasks. As the learning process resembles gameplay, students are more likely to participate willingly and engage in collaborative interactions throughout the activity. Notably, teachers recognized that the collaborative problem-solving tasks within Minecraft encouraged ongoing communication and cooperation among students, resulting in the production of shared outcomes. This not only enhanced collaborative problem-solving skills but also provided socially withdrawn or passive students with meaningful opportunities to actively communicate during task execution in the online space. Such engagement supported the development of new peer relationships and fostered a more inclusive and collaborative classroom culture. Given that today's adolescents tend to form and maintain social relationships through online platforms, integrating Minecraft into instruction may also serve as an educational mechanism for promoting emotional connectedness, strengthening peer collaboration, and cultivating interpersonal skills.

*There was one student in my class who used to sleep through every class. I see that class five hours a week, and I'd only seen him with his eyes open once. But when I announced the Minecraft project, he said he wanted to join. I told him, "I won't let you in if you sleep!" and he promised he wouldn't. And surprisingly, he came—even on Saturdays! I honestly didn't think he would. And you know, he was a bit of a loner before, but I saw him starting to get along with the other kids through the project. That was meaningful. (Teacher E interview)*

#### 4.3.2. Enhancement of Learners' self-directed learning and Active Participation

Teachers perceived that the use of Minecraft in instruction effectively encouraged students to participate more actively and autonomously in learning, mainly due to their pre-existing high interest in the platform itself. Unlike traditional lessons that often require external motivational

devices, Minecraft-based classes naturally elicited student engagement without additional effort. Teachers reported that learners perceived unfamiliar content areas as intriguing learning opportunities and, through peer collaboration and collective problem-solving, took ownership of the learning process. Significantly, learners demonstrated agency by independently exploring and experimenting with the platform's digital functions without explicit teacher intervention. They actively discovered solutions and shared them with their peers in real-time—experiences they described as enjoyable and game-like. This contrasts with conventional paper-based or textbook-centered learning, which was often seen as less engaging or compelling. Such findings suggest that Minecraft can serve as a multifaceted educational tool that enhances the motivation and immersion of marginalized learners, including multicultural students and those with introverted personalities. By fostering learner autonomy and active engagement, the platform supports inclusive participation and enables personalized learning paths within the digital classroom.

*It was a big school, but there were also many multicultural students, and communication wasn't always easy. There were students who were constantly sidelined in regular classes, but in this class, at least, they seemed to genuinely want to try something, felt genuinely interested, got involved, and were given a role to play. I think just having that kind of opportunity must have been something new and meaningful for them. And the fact that it shifted toward student-centered participation—I feel like that in itself is something really positive. (Teacher D interview)*

#### 4.3.3. Promotion of Creative Output through a High Degree of Freedom

Minecraft, with its high level of learner familiarity and extensive user freedom, facilitates the production and sharing of creative outputs beyond the constraints of the physical classroom, thereby offering learners diverse and active communication experiences in online environments. Teachers recognized Minecraft as a metaverse platform well-suited for educational contexts, in

which the learning process inherently leads to the generation of creative artifacts. As such, it provides students with authentic experiences as digital media prosumers and serves as an effective tool for eliciting original ideas. Notably, teachers emphasized that Minecraft is familiar to students of all ages—from elementary to high school—and that its affordance of user freedom allows learners to engage continuously with its various functions. Through iterative processes involving experimentation and failure, learners refined their outputs, thereby enhancing their analytical thinking and creative problem-solving skills. These findings suggest that remote learning spaces designed with high learner autonomy can foster the development of sophisticated thought, facilitate the generation of creative ideas, and enhance skills in systematic planning and coordination.

*For example, the students had to build a gymnasium. They started by constructing the outer frame of the building—but then they had to figure out how to build the stairs inside. At first, the ones who hadn't thought it through just wandered around, unsure of how to even begin. They tried lighting fires, even setting up campfires—just messing around. But eventually, they realized they needed to hollow out the inside. They had not just randomly dug, but they hadn't planned enough space to install stairs in the first place. So they realized, "Ah, this won't work," and started focusing on finishing the first floor first, then decorating it, and only after that did they move on to the second floor. It helped them start thinking in more structured and sequential ways. (Teacher E interview)*

#### 4.3.4. Increased Sense of Achievement and Satisfaction with the Learning Experience

While concerns about excessive gaming and skepticism toward the educational use of games remain prevalent, teachers highlighted that students who were typically passive in traditional classroom settings exhibited notable behavioral shifts when participating in Minecraft-based lessons. In these game-integrated learning environments, such students communicated more actively with peers, received praise and positive feedback, and experienced a heightened sense of achievement—factors that collectively

enhanced their overall learning efficacy. Teachers observed that learners who often felt discouraged or inferior in conventional classes—leading to low motivation and learned helplessness—were able to complete creative tasks successfully using a familiar game-based platform. By receiving encouragement and recognition from their peers for their accomplishments, students not only gained a sense of fulfillment but also developed greater agency and self-esteem as members of a learning community. These findings suggest that for today's digitally native youth, leveraging familiar digital tools like Minecraft can foster meaningful educational engagement. Such tools should be consistently integrated to help students fully express their strengths and individuality, ultimately driving positive personal and academic development.

*Especially for kids who've always felt like they weren't good at anything, who kept failing and became discouraged in other subjects, too... they'd often just shut down. But with this, they were using something they're good at—games—as a tool to build something. After creating something original and getting praise and encouragement from their peers, they began to think, "Hey, maybe I can do something." I even had a student who used to turn in blank tests start writing at least a sentence. That kind of shift, I think, was the most significant change. (Teacher F interview)*

## 4.4 Challenges in Implementing Minecraft-Based Instruction

### 4.4.1. Limited Teacher Proficiency in Minecraft and Pedagogical Design

Teachers recognized that effective educational use of Minecraft and other metaverse platforms requires not only a conceptual understanding of how digital media environments operate but also practical digital literacy, including technical skills to navigate and manipulate digital tools. While they acknowledged the importance of continually enhancing teachers' digital competencies to deliver personalized instruction for digitally native learners, many pointed out that the initial barrier to entry for Minecraft-based instruction is relatively high due to the need to master the platform's functions and understand how to integrate them into instructional

practice. Some teachers expressed concern that the complexity of the platform, combined with the demand for technical fluency, made it challenging to design and implement lessons confidently in the early stages. However, through hands-on experience, many also discovered that even a basic understanding of Minecraft's features could suffice for effective lesson design. This shift in perception suggests the need to reconsider the assumptions about what is required to teach with digital tools. It also highlights the importance of sustained professional interest in digital education and the need to provide structured opportunities for teachers to enhance their digital literacy and explore pedagogical strategies using digital platforms like Minecraft.

*But honestly, that's what made it hard for me. I wasn't used to navigating a world from that perspective. If you've played games before, you're probably used to moving with both hands—your left hand on the keyboard and your right on the mouse. But for someone like me who hasn't played games, that coordination was tough. It probably took me about a week to get used to it. (Teacher E interview)*

#### 4.4.2. Concerns About the Gap in Student Engagement Between Minecraft and Non-Minecraft Lessons

Teachers expressed concern that the high level of student interest and curiosity elicited by Minecraft-based lessons, due to the platform's nature as a game-based digital media tool, may inadvertently diminish students' engagement in traditional, non-Minecraft classroom lessons. While Minecraft-based activities were seen as highly effective in capturing learners' attention, teachers noted the potential adverse spillover effect—namely, that the excitement generated by game-based learning could lower students' motivation toward conventional instructional approaches that do not incorporate such digital tools. They emphasized the need to carefully consider how to address this imbalance, acknowledging that it is neither feasible nor pedagogically appropriate to use Minecraft in every lesson. Particularly in elementary education, where developmental characteristics vary, face-to-face instruction and direct knowledge

transmission remain necessary and valuable. These concerns highlight the need for a balanced and complementary integration between digital learning environments and traditional classroom settings. In this context, blended learning models that thoughtfully combine online and offline instruction may be essential to sustaining learner motivation while preserving pedagogical diversity.

*Especially with elementary school students, there are times when more structured, direct instruction is necessary. But after doing a fun, interactive class like this, those more traditional lessons might feel dull in comparison—and that could lead to some negative consequences. Also, I've seen situations where teachers try to force Minecraft into a lesson just for the sake of using it. I think we need to avoid that kind of forced application. It has to make sense pedagogically. (Teacher D interview)*

#### 4.4.3. Limitations of Minecraft's Educational Features

Although Minecraft is available in both a general gaming version and an educational version, teachers using Minecraft: Education Edition in classroom settings reported several limitations that hinder its effectiveness as a teaching tool. A major concern was the absence of built-in voice support, which impedes seamless communication during instruction. Teachers also pointed to functional shortcomings such as restricted platform access through educational institutions, limitations on the number of simultaneous users, and insufficient tools for teachers to manage and monitor students' activities. These constraints are particularly problematic in remote learning contexts, where the platform is expected to serve as a comprehensive virtual learning environment. Teachers noted that the educational version of Minecraft often only supports access when all participants are located within the same local network, which significantly restricts its usability for online or hybrid learning scenarios. These limitations diminish teachers' willingness to implement Minecraft-based instruction consistently and highlight the need for improvements and alternative solutions to ensure its continued viability as an educational platform.

*There used to be features like the fill function that allowed us to quickly help students without having to use commands or anything complicated. However, those features are no longer available in the current version. ... I think it would be helpful if the education edition included more functions that allow teachers to manage or guide students more easily. (Teacher B interview)*

#### 4.4.4. Insufficient Budget for Licensing and Operational Support

Teachers reported that one of the significant challenges in implementing Minecraft-based instruction was the lack of school-level budgeting for purchasing educational licenses. Despite recognizing the need for institutional support to acquire official Minecraft licenses for classroom use, many schools have not allocated specific funds for this purpose. Moreover, some administrators and educators expressed discomfort with using school budgets to purchase what is perceived as a game license, further complicating the procurement process. As a result, teachers often relied on students' licenses—obtained with parental consent—or explored alternative funding options such as using class operation funds, research group budgets, or discretionary project funds. In some cases, teachers borrowed accounts from foreign co-teachers collaborating on joint lessons. These stopgap measures underscore that, under current conditions, the implementation of Minecraft-based learning often relies on the personal initiative and effort of individual teachers. This underscores the urgent need for structural support and dedicated budget allocation as a foundational prerequisite for promoting digital learning environments and sustaining remote instruction using educational technologies like Minecraft.

*At our middle school, approximately 30–40% of students in each class already had the Java Edition. With their permission, we set their accounts to auto-login on the school computers... We asked the school about getting funding for licenses, but there wasn't a budget prepared in advance. Also, some people are uncomfortable with the idea of purchasing a game, which creates additional resistance. (Teacher F interview)*

## 5. Discussion and Conclusion

### 5.1. Discussion

This study examined teachers' instructional experiences with Minecraft as a remote learning tool. The findings reveal several key insights. First, teachers adopted Minecraft primarily due to its capacity to expand digital learning environments, support inquiry-based instruction, and integrate game-based motivational systems. During the COVID-19 pandemic, as physical classrooms were shut down, teachers leveraged Minecraft's 3D virtual environment to reconstruct time and space flexibly, providing students with novel immersive learning spaces. Whereas prior remote instruction had heavily emphasized content delivery[28], Minecraft enabled a pedagogical shift toward student-centered exploration and creative expression. Rather than serving merely as an online tool, Minecraft functioned as an immersive metaverse-based learning ecosystem that ensured both continuity of instruction and diverse learning experiences, even in remote settings[18].

Second, teachers implemented various pedagogical strategies to link real-world and virtual experiences in Minecraft-based remote classes. For instance, they constructed digital twins of schools, local communities, and cultural heritage sites, allowing students to simulate real-world problems in virtual spaces. These contextualized tasks helped deepen learners' understanding and promoted higher-order thinking through iterative experimentation and feedback[29]. In parallel, storytelling techniques were integrated to place learning processes within narrative structures, enhancing engagement and contextual comprehension while fostering student-led problem-solving. Teachers also utilized NPCs as assistant instructors to convey learning goals, provide immediate feedback, and conduct formative assessments. This approach addressed the challenge of offering individualized support in real-time during remote instruction[30]. To overcome the functional limitations of Minecraft—such as the absence of voice chat or learning analytics—teachers integrated external educational tools like Microsoft Teams, Zoom, and YouTube to support learner interaction and content sharing. Collaborative, production-centered tasks were also

introduced to cultivate peer learning cultures and reinforce student communication and cooperation, even in virtual environments[31].

Third, teachers perceived Minecraft-based instruction as enhancing learners' collaborative problem-solving skills, self-directed learning, and learning satisfaction. Performing team-based tasks in virtual spaces promoted frequent and meaningful communication among students and fostered a "reciprocal learning" structure in which advanced learners supported their peers. The collaborative experiences led to a sense of social presence[32], motivating even disengaged students to participate actively. Teachers viewed these changes as reinforcing motivation and a sense of accomplishment, thereby contributing to sustained engagement. Teachers thus viewed Minecraft as offering comprehensive learning benefits, including both cognitive development and socio-emotional support, even in remote learning contexts.

Fourth, several structural and practical limitations were identified. Teachers unfamiliar with digital game environments reported a steep learning curve related to 3D navigation, command execution, and integrating Minecraft with other technologies. Although the immersive nature of game-based learning was motivating, some teachers noted the risk of reduced student interest in traditional lessons. In addition, technical limitations of Minecraft: Education Edition—such as the lack of voice communication, restrictions on user access, and inadequate learner management features—were viewed as barriers to effective classroom management and interaction. Moreover, challenges related to curriculum alignment, assessment design, and communication with parents posed further burdens, underscoring the need for institutional and professional support to effectively integrate Minecraft into formal education systems.

## 5.2. Implications for Practice

Based on the findings, this study offers several practical implications.

First, to support multilayered learning experiences in metaverse-based environments, enhancing teachers' instructional design competencies is essential. Virtual world-building activities must be tightly aligned with curriculum goals to help learners explore, model, and solve

real-world problems in digital twin environments. Developing teachers' technological pedagogical content knowledge and context-sensitive lesson planning skills is essential.

Second, maintaining learner autonomy and engagement while ensuring structured instruction requires more sophisticated support features within Minecraft. For instance, in-game NPCs can be programmed to deliver learning objectives, conduct formative assessments, and provide real-time feedback. Additional features, such as voice and video chat, learning history tracking, and data analytics, should also be incorporated.

Third, assessment systems must be established to connect Minecraft activities to formal evaluation. Automatically collected digital evidence—such as gameplay logs, screenshots, and audio recordings—should be visualized and linked with project rubrics, self-assessments, and peer assessments. This approach would enable the transparent evaluation of learners' problem-solving and collaboration skills while also helping schools and parents to recognize the educational value of game-based instruction.

Fourth, there is a need to provide rich and well-structured teaching and learning resources to enhance teachers' accessibility to Minecraft and the feasibility of implementing lesson designs. In particular, it is important to offer validated instructional maps that can be used educationally in alignment with subject-specific achievement standards, along with packaged resources such as lesson plans by session, worksheets, assessment rubrics, applicable quest scenarios, and guidelines for recording learning data and providing feedback.

Fifth, the expansion of learning space emphasized during pandemic-era remote instruction can be reinterpreted as the expansion of learning experiences in current face-to-face and blended learning environments. Minecraft should not be positioned as a tool that replaces classroom instruction but rather as an extended learning environment that enables inquiry-, production-, and simulation-based activities that are difficult to implement within conventional classroom settings alone. The instructional strategies identified in this study—including digital twin-based tasks, storytelling-driven inquiry design, and NPC-supported step-by-step guidance and feedback—can be reconfigured to promote learner engagement and

strengthen the continuity and personalization of learning in digital instructional contexts.

### 5.3. Limitations of the study

Despite its significant findings, this study had some limitations that offer direction for future research.

First, During the COVID-19 pandemic, schools implemented a range of instructional modalities depending on local conditions and school circumstances, including fully online, blended, and face-to-face formats. However, because this study was designed to examine teachers' overall experiences of remote instruction, it did not explicitly identify or compare differences in teaching experiences across these specific modalities. Future research should distinguish among instructional formats and investigate how teachers' strategies, interaction patterns, perceived outcomes, and challenges may vary by delivery mode.

Second, because this study relied mainly on teacher interviews, it lacked quantitative verification of learner experiences or outcomes. Future research should incorporate quantitative surveys, behavioral log analysis, and pre- and post-assessments to objectively measure learning effects and triangulate findings with qualitative data, thereby enhancing the reliability and validity of the results.

Third, remote instruction during the COVID-19 period was implemented in diverse ways. While some schools adopted fully online learning, others—particularly smaller schools—operated through a blended format combining in-person and remote classes. Future research should consider disaggregating data by instructional format to provide more nuanced insights into the differential effects of fully remote versus hybrid teaching environments.

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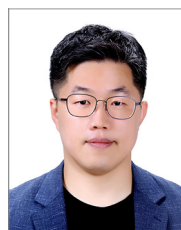
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부 록

〈표 1〉 참여자의 특성

구분	성별	직위	담당 교과	교육경력
A	남자	초등학교교사	전교과	20
B	남자	초등학교교사	전교과	15
C	남자	초등학교교사	전교과	10
D	남자	초등학교교사	전교과	16
E	여자	중학교교사	정보	11
F	남자	중학교교사	국어	6
G	여자	중학교교사	영어	9

〈표 2〉 인터뷰 질문

구분	질문
교육적 이유	<ul style="list-style-type: none"> <li>· 마인크래프트 활용 교육을 시작하게 된 동기는 무엇인가요?</li> <li>· 여러 플랫폼 중 마인크래프트를 선택한 이유는 무엇인가요?</li> <li>· 마인크래프트 활용 교육의 목적은 무엇인가요?</li> <li>· 마인크래프트 활용 교육을 통해 기대하는 것은 무엇인가요?</li> <li>· 마인크래프트 활용 교육의 대표적인 사례는 무엇인가요?</li> </ul>
교수 전략	<ul style="list-style-type: none"> <li>· 마인크래프트 활용 수업에서 교육과정 재구성은 어떻게 하나요?</li> <li>· 마인크래프트 활용 수업에서 선호하는 교수학습 방법과 그 이유는 무엇인가요?</li> <li>· 마인크래프트 활용 수업에서 주로 어떤 학습 과제를 제시하나요?</li> <li>· 마인크래프트 활용 수업에서 아바타(캐릭터), 오브젝트, NPC 등을 어떻게 활용하나요?</li> <li>· 마인크래프트와 어떤 에듀테크를 연계하여 활용하나요? 그 이유는 무엇인가요?</li> <li>· 마인크래프트 활용 수업을 위해 기타 고려해야 할 것은 무엇인가요?</li> <li>· 마인크래프트 활용 수업을 위해 어떤 준비를 해야 하나요?</li> <li>· 원활한 마인크래프트 수업을 위해 지켜야 할, 정해진 규칙이 있나요?</li> <li>· 수업을 위한 규칙이 지켜지지 않았을 때 어떤 문제가 발생하였나요?</li> </ul>
교육 효과	<ul style="list-style-type: none"> <li>· 학생에게 나타난 긍정적 또는 부정적인 변화나 효과는 무엇인가요?</li> <li>· 교사에게 나타난 긍정적 또는 부정적인 변화나 효과는 무엇인가요?</li> <li>· 주변(관리자, 동료 교사, 학부모 등)의 반응은 무엇인가요?</li> </ul>
교육적 어려움	<ul style="list-style-type: none"> <li>· 마인크래프트 활용 수업의 어려운 점은 무엇인가요?</li> <li>· 어려운 점을 극복하기 위해 어떤 노력을 하였나요?</li> </ul>

〈표 3〉 코딩 결과

핵심 범주	상위 범주	주요 코드
교육적 이유	제한된 교실 공간을 넘어선 디지털 학습공간 확장	공간적·시간적 제약 확장, 물리적 교실 확장, 디지털 교육 공간, 디지털 공간에서의 학교 활동 및 문제 해결 경험
	몰입형 가상세계에서의 학습자 중심적 탐구 환경 제공	몰입도, 참여도, 호기심과 탐구심 촉진, 3D 가상환경, 실생활 적용 가상체험, 총체적 학습 역량 함양
	게임 기반 학습을 통한 학생의 학습 참여 동기 강화	게임의 흥미 요소, 학습 참여 유도 및 참여 동기 강화, 상호작용 촉진
교수 전략	디지털 트윈 구축을 통한 실세계 연계 학습	디지털 트윈, 실세계 문제 해결 경험, 현실세계 이해도 촉진, 협력적 소통 기회 확대
	스토리텔링을 활용한 몰입적 수업 설계	스토리텔링 수업 설계, 마인크래프트의 스토리 창작 기능 활용, 학습 내용의 스토리텔링 구현, 몰입적 학습 경험 제공, 스토리라인에의 능동적 참여
	NPC를 활용한 학습 안내 및 스캐폴딩	NPC, 학습 안내, 스캐폴딩, 학습 정보 제공, 학습 이해도 제고, 자기주도적 학습 기회, 즉각적 피드백, 보조교사
	타 에듀테크와의 연계를 통한 학습 효과 확장	에듀테크와의 연계, 다양한 플랫폼 병행 활용, 상호작용 촉진, 학습 경험 확장
	동료 간 소통과 협력 학습 촉진	협력적 소통 경험, 공동 제작 중심 과제 부여, 디지털 소통 공간, 협업적 학습 역량
교육 효과	적극적 의사소통 및 협력적 문제 해결 능력 향상	적극적 의사소통, 활발한 상호 교류, 협력적 문제 해결, 협력자 및 조력자로서의 교사, 의사소통 역량
	학습자의 자기주도성 및 주도적 참여 증대	흥미도, 주도적 참여, 참여 중심 수업, 학습자 주도성
	높은 자유도를 통한 창의적 결과물 생성 촉진	자유도, 적극적 소통 경험, 창의적 결과물 생산, 사고 정교화, 창의성 및 분석력 향상
	학습자의 성취감과 수업에 대한 만족도 증가	성취감, 긍정적 피드백, 수업 효능감, 자존감 형성, 수업 만족도
교육적 어려움	교사의 마인크래프트 사용 역량 및 교수법 숙지 부족	마인크래프트 사용법, 교수법, 메타버스 작동 원리, 디지털 도구 조작 능력
	마인크래프트 미 활용 수업과의 학습자 흥미 격차 우려	학습 흥미 격차, 일반 교실 수업과의 격차
	마인크래프트 플랫폼의 교육적 기능 제약	플랫폼의 기능 제약, 교육용 버전의 제한
	라이선스 확보 및 운영을 위한 예산 부족	라이선스 확보, 예산 부족