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Distance Learning Where Children Freely Share Thoughts in a Metaverse

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This study examines how children from different regions can voluntarily share ideas through metaverse-based distance learning and how teachers observe their interactions. To explore this, we conducted three learning activities combining metaverse-based and face-to-face sessions. Data collection included a questionnaire survey completed by 25 students and paper-based interviews with two teachers. Our results indicate that the metaverse encouraged voluntary dialogue by reducing tension and enabling freer interaction compared to face-to-face settings. Teachers primarily observed students using four indicators: "signals during a call," "conversation range," "avatar movement," and "chat." Although the study was limited in duration, scope, and sample size, it provides preliminary insights into the metaverse's potential in compulsory education. Future research should analyze dialogue content and identify strategies to foster more active peer interaction in virtual learning environments.

Keywords: distance Learning, metaverse, children, dialogue

Introduction

Background

Distance learning is increasingly employed in compulsory education, especially elementary and junior high schools, to facilitate continuous information exchange among children from different regions. Compulsory education is the elementary and junior high school education stage. In Japan, for example, remote classes connect multiple schools, including those in rural areas and remote islands, allowing children to interact online. These classes promote communication skills among students of the same age group and foster peer interaction. A distinguishing feature of Japanese distance education is that most exchanges occur at the classroom level (MEXT, 2020). In China, distance learning in compulsory education is used to reduce educational disparities and enhance instruction quality. In these cases, high-performing urban teachers conduct lessons simultaneously with rural schools through online platforms (Tian et al., 2024). Similarly, in Malaysia and Indonesia, cross-border distance learning initiatives connect urban and rural elementary schools, enabling online interaction (Rini et al., 2024). Although face-to-face interaction among children is effective, frequent in-person exchanges are often challenging for those in remote areas. In this context, distance learning offers a practical solution, overcoming geographical constraints and should be implemented where necessary.

While distance learning takes place online, children should remain the central agents of interaction. Instead of having teachers transmit knowledge or requiring children to make presentations in predefined formats, a learning style wherein children voluntarily seek out information and learn through active interaction with peers should be promoted (MEXT, 2023). Japan's compulsory education system increasingly emphasizes integrating individualized and collaborative learning. This approach encourages children to act independently while collaborating with others as necessary (Ministry of Education, Culture, Sports, Science and Technology, 2024). With the widespread use of mobile PCs and other digital devices in schools, remote classes can now be conducted without special equipment. This enables students to learn collaboratively beyond spatial constraints. In this context, passive learning—where students simply follow the teacher's instructions and progress at the same pace—should be replaced with autonomous, dialogic learning. Hence, teachers should avoid delivering uniform, top-down instructions throughout the class in distance learning within compulsory education. Students should instead be encouraged to engage in voluntary dialogue and exchange diverse perspectives. However, to realize remote classes supporting autonomous and interactive learning among students, the tools that have commonly been used still present limitations. Videoconferencing platforms including Zoom, widely utilized in distance education, lack social affordances that encourage peer interaction and meaningful connections among students (Sriworapong, 2022). This is because videoconferencing platforms lack the concept of distance between individuals and do not offer an interface that allows individuals to move freely, making it difficult for users to perceive each other's spatial relationships (Inoue, 2020). Many video conferencing platforms offer features that allow for group work by creating separate rooms for small groups in addition to the main conference room. However, these are group activities primarily led and set up by the teacher, which makes it difficult for free dialogue to emerge among children. Furthermore, learning via videoconferencing platforms reduces interaction fluency, slows down interactions, and decreases attention compared to traditional education (Rapanta, 2020). Additionally, these tools offer limited opportunities for personalized interaction, customized learning, or peer-to-peer exchanges between teachers and students (McClure, 2021). Furthermore, when learners with low self-regulated learning skills, such as elementary school students, learn in asynchronous environments, they may struggle to employ efficient learning strategies and experience increased cognitive load (Gorbunova, 2024). Asynchronous communication tools, such as Google Chat or social networking services, have been utilized in remote classes. These tools can support learner-centered approaches, but students generally tend to prefer synchronous over asynchronous learning environments (McClure, 2021). Given the developmental needs and learning characteristics of children in compulsory education, a preference for synchronous settings is expected. In summary, distance learning conducted through videoconferencing or asynchronous platforms frequently lacks meaningful peer interaction and connectedness. Consequently, realizing distance learning environments wherein children can engage in free, voluntary dialogue and collaboratively share diverse ideas remains challenging. This means that the face-to-face learning style, where children voluntarily seek out information and learn through active interaction with peers, has not been realized online in compulsory education.

To realize remote classes that support autonomous learning and idea-sharing among children, we propose using a metaverse environment that enables children to act relatively freely online. This would replicate face-to-face settings. Technological advancements in the recent years have enabled the implementation of metaverse environments at a relatively low cost. The definition of the metaverse varies across studies. For example, The Metaverse Roadmap (Smart, 2007) classifies the metaverse into four categories: augmented reality (AR), lifelogging, mirror worlds, and virtual reality (VR). According to Onu (2022), the metaverse distinguishes itself from AR and VR through three defining characteristics: shared, persistent, and distributed. In this study, we define the metaverse as "a virtual space where learners can move freely with their avatars and converse freely with other avatars," irrespective of whether the virtual space is two-dimensional or three-dimensional.

The metaverse offers advantages over traditional remote learning. McClure (2021) points out that the metaverse allows learners to study at their own pace compared to conventional videoconferencing tools. Furthermore, Sriworapong (2022) demonstrated that remote learning using the metaverse is superior to video conferencing systems in terms of social functions, and specifically, two-dimensional metaverse spaces excel in usability. Additionally, the metaverse is effective for experiential learning (Onu, 2022), enabling experiences that are not possible through text-based communication. So, the metaverse enables children to interact relatively freely, replicating face-to-face interaction. This capability makes the metaverse a powerful tool for supporting distance learning in compulsory education through self-directed interaction and idea-sharing. Therefore, the metaverse can be leveraged to facilitate remote classes that allow children to engage in voluntary dialogue and share their perspectives with other students collaboratively.

Previous Research

Studies have highlighted the potential of metaverse environments for collaborative learning. For instance, Damaševičius (2024) reported that metaverse-based collaboration enhances peer interaction and teamwork, mirroring the effectiveness of face-to-face settings. Hatmanto (2023) found that multicultural learners working together in metaverse spaces could deepen cross-cultural understanding. Onu (2024) emphasized that the metaverse provides a heightened sense of social presence and immersive experiences, surpassing conventional classroom settings. Onu also observed that avatars in the metaverse benefit shy or isolated students by reducing social barriers through anonymity. While learners are rarely anonymous in school education, acting through avatars in the metaverse eliminates the psychological barriers associated with direct face-to-face interaction. Collaborative learning in the metaverse, therefore, has the potential to produce educational outcomes comparable to, or even exceeding, those of in-person classes. Despite these advantages, some challenges remain. Hayashi (2022) identified difficulties in conveying nonverbal information and understand others' reactions in metaverse environments without head-mounted displays. Similarly, Sawasaki (2022) noted that the absence of visible facial expressions during interaction may cause anxiety. Additionally, some learners may struggle to find meaningful reasons to engage with the metaverse. These limitations highlight the need to clarify the unique value of metaverse-based learning environments, particularly when compared to face-to-face and conventional online settings.

While studies on metaverse applications in compulsory education remain limited, several implementations have been reported. Wu et al. (2023) showed that metaverse environments effectively support children's remote collaboration experiences. Kanamori (2025) found that metaverse-based practices, when combined with appropriate support, can enable children to participate in activities within a safe environment, enhancing both their engagement and sense of accomplishment. Kurata et al. (2024) emphasized the importance of self-regulation skills in fostering children's connections with peers during collaborative learning in the metaverse. Watanabe (2024) introduced classroom practices wherein elementary students engaged in creative activities integrating both the metaverse and real world settings. These findings suggest that distance learning via the metaverse can be effectively implemented in compulsory education when combined with meaningful dialogue and appropriate teacher support. However, whether children can share diverse ideas through voluntary and spontaneous interaction in these environments remains unclear. While Kanamori (2025) highlighted the need for timely and valid feedback from facilitators, the cues that teachers use to provide feedback in metaverse settings are not well known. This gap is particularly critical for children with cognitive or emotional difficulties, who tend to face challenges with remote communication (Wu et al., 2023). This limitation underscores the importance of a teacher's presence and guidance. Addressing these gaps would contribute valuable insights toward realizing effective distance learning through the metaverse and thus warrant further investigation.

Given these points, collaborative learning utilizing the metaverse is expected to increase in compulsory education, necessitating learning where children share diverse ideas through voluntary and open dialogue. However, it remains unclear whether metaverse-based collaborative learning can enable children to share diverse ideas through voluntary and open dialogue to the same extent as face-to-face settings. Therefore, by demonstrating the differences and similarities in learning between metaverse-applied practices and face-to-face collaborative learning, this study can provide practical insights for realizing effective metaverse-based collaborative learning. Furthermore, as Kanamori (2025) states, children's collaborative learning requires timely and effective feedback from teachers acting as facilitators. By examining this in conjunction with the content of teacher support during metaverse-applied practices, these practical insights can be further strengthened.

Purpose

This study aims to implement a form of distance education within a metaverse environment where children share diverse ideas through voluntary and open dialogue. It further seeks to evaluate the effectiveness of metaverse-applied practice by comparing learning outcomes between metaverse-applied practice and face-to-face practice. In other words, the research question for this study is: "How do the characteristics of interaction activities, where children share diverse ideas through voluntary and open dialogue, differ between face-to-face and metaverse environments?" To achieve this, we conducted remote classes, connecting children from different regions via the metaverse. Additionally, to compare the characteristics of this remote instruction with those of face-to-face learning, we will implement both styles. While this comparison through actual practice prevents investigation in a completely controlled environment, it is necessary to gain insights for achieving the objectives of this study. The study explored whether voluntary interactions foster the sharing of varied perspectives. Additionally, we analyzed how teachers observe and support collaborative learning in this virtual environment.

Practice

Overall Learning Design

Blended learning—where distance learning is positioned as preparatory learning before face-to-face interactions—has demonstrated increasing effectiveness in the recent years (Nagahama et al., 2022). In this study, metaverse-based distance learning was implemented as a preparatory learning method prior to in-person exchange activities. The learning design incorporated three sessions based on the three-stage learning model (Ikeda, 2015). The sessions aimed to promote an understanding of efforts toward reconstruction and peace from various perspectives. The first session (June 2024) was a metaverse-based distance learning activity designed for icebreaking. The second session (July 2024) also utilized the metaverse and focused on exchanges of opinions through dialogue, preparing students for the subsequent face-to-face interactions. The third session (August 2024) consisted a face-to-face learning activity wherein students engaged in dialog-based opinion exchange.

Practice environment

The participants comprised 25 students: 14 fifth- and sixth-graders from X Elementary School in Nagasaki Prefecture and 11 sixth- and seventh-graders from Y Elementary and Junior High School in Fukushima Prefecture. These two schools were selected for this study because both are located in regions historically affected by atomic bombings in Japan and had a history of regular annual exchanges. The metaverse platform used for the learning environment was oVice, a 2D metaverse platform developed by oVice Corporation that supports up to 200 simultaneous users. A 2D metaverse was selected because of its user-friendly features and simpler interface, making it more accessible for beginners in online learning (Sriworapong, 2022). The third session, conducted face-to-face, took place at various locations in Nagasaki City, with all 11 students from Y Elementary School attending in-person.

Contents of the Learning

The intervention consists of three sessions. The first session is designed for ice-breaking. Figure 1 shows a scene from the first distance learning session. The first distance learning the primary objectives of this session were to familiarize students with the metaverse environment and foster relationship-building among participants. Sato (2019) suggested that addressing peers by name can serve as a catalyst for developing interpersonal relationships. Based on this, the session aimed to encourage spontaneous interaction between children who had never met before. The session featured an activity designed to facilitate smoother interactions in subsequent sessions. Avatars were freely customizable, and display names were hidden to ensure participants could not identify one another based on avatar appearance alone. Specifically, the avatar name displayed in the metaverse was formatted as "(region) & (pre-assigned number)". Instead, personal information, such as hobbies and interests, was shared beforehand. Using this information, the students engaged in a 20-minute activity (excluding explanation and reflection time), where they repeatedly asked and answered questions to deduce the identities of their peers' avatars. It should be noted that although this 20-minute activity was intended to engage the children in spontaneous and open dialogue, it was not positioned as a learning experience to share diverse ideas. Its sole purpose was for icebreaking and familiarization with the operation of the Metaverse.

Figure 1.
A scene from the first distance learning session

The second session was a practice aimed at sharing diverse perspectives through spontaneous interaction in the metaverse. Figure 2 shows a scene from the first distance learning session. This session aimed to explore the contributions of seven individuals who played a key role in Nagasaki's reconstruction, emphasizing that the recovery was driven by the efforts of its citizens. The activity was also designed to connect with a later session, where students would exchange opinions after visiting historical sites in Nagasaki. Before the metaverse-based distance learning session, a preliminary activity was conducted in which the children watched a video on Nagasaki's reconstruction and reflected on the contributors who left the strongest impression on them. In the main session, 1) the children participated in a 15-minute open discussion, sharing insights about the individuals who made a lasting impression. Subsequently, 2) students who selected the same historical figure discussed the qualities they admired and shared their reflections in the metaverse chat for 20 minutes. The chat was open to all participants and thus allowed everyone to view the shared content. Then, 3) the children had a 10-minute open discussion based on the ideas presented in the chat. Finally, 4) the session ended with a 15-minute reflective activity, during which all participants explored the concept of historical fading and how to prevent it. Notably, the learning in which children shared diverse ideas through voluntary and open dialogue occurred during 1) the 15-minute open discussion, 2) the 20-minute metaverse chat, and 3) the subsequent 10-minute open discussion. Throughout these periods, teachers observed the children's interactions on their device screens.

Figure 2.
A scene from the second distance learning session

The third session was a face-to-face practice, which included activities for sharing diverse perspectives through spontaneous interaction. This session, held on the final day of the exchange program, aimed to facilitate discussions on strategies for future reconstruction and peacebuilding. 1) It began with a review of previous activities (5min), 2) followed by participant presentations on initiatives implemented in their respective prefectures(20min). 3) This was followed by a 10-minute open interaction for general exchanges(10min). Finally, 4) participants summarized their discussions and recorded them on a cloud-based platform as a form of reflection(15min). Learning where children shared diverse ideas through voluntary and open dialogue occurred only in (3) the 10-minute open interaction.

Throughout all these activities, one teacher from Nagasaki served as the main teacher, and one teacher from Fukushima served as the sub-teacher. Moreover, during the learning activities focused on children sharing diverse ideas through voluntary and open dialogue, these two teachers strictly maintained their roles as facilitators, observing and supporting from within the metaverse space.

Survey and Analysis Methods

Research Design

This study adopts a mixed-methods approach. For the learners (children), a questionnaire combining a four-point Likert scale and open-ended questions was used. The four-point Likert scale items were designed to evaluate learning aimed at children sharing diverse ideas through voluntary and open dialogue. These items were developed and validated by the first and second authors of this paper. Furthermore, the questionnaire items were reviewed in advance by administrators and teachers from both Nagasaki and Fukushima to ensure their content and phrasing were appropriate for children's responses. Conversely, for the teachers (facilitators), an open-ended questionnaire was administered to elicit specific strategies for observation and support. Both surveys were conducted immediately after the respective interventions.

Survey and Analysis of Children's Learning Together

Table 1 outlines the components of the questionnaire survey, which aimed to assess children's readiness to voluntarily express their ideas with others. As shown in Table 1, there are a total of nine items in the survey. The survey was conducted after all interaction sessions, both in metaverse and face-to-face, had concluded. The questionnaire included questions addressing aspects such as timing, the quality of engagement (e.g., perceptions of tension, freedom, and initiative), and the exchange of diverse ideas. Each item was assessed independently for both the metaverse and face-to-face environments using a four-point Likert scale. For analysis, responses were categorized as either positive (4: strongly agree, 3: agree) or negative (2: somewhat disagree, 1: strongly disagree) and examined using the exact binomial test. The tool used for the exact binomial test was R 4.2.0. Additionally, open-ended responses were gathered to explore participants' perspectives on the strengths and overall impressions of each interaction type.

Survey and Analysis of Teacher Observation

We interviewed two elementary school teachers responsible for facilitating exchange learning activities in the metaverse to understand their approaches to observing students during the sessions. Specifically, they were asked two key questions: "How did you attempt to observe the children on the PC screen during the practice?" and "What aspects of observation during the lesson implementation were effective or challenging?" Their response were collected through a paper-based interview conducted via Google Forms. The data were analyzed using a case study approach, where teachers' observations were examined in relation to the classroom setting. Initially, individual comments were coded into subcategories with assigned labels, which were then grouped into broader categories, each with its own label. The analysis was conducted collaboratively by the first and second authors, both of whom specialize in teacher education at universities. When differences in interpretations arose, a consensus was reached through discussion.

Table 1

Questionnaire Survey

No	Category	Item
1	Exchange Learning	I'm glad I had the opportunity to interact with students from the other school in oVice before meeting them face-to-face.
2	Dialogue (Tension)	I felt nervous when interacting with students from the other school during the oVice learning experience.
3	Dialogue (Tension)	I felt nervous when interacting with students from the other school during the face-to-face learning session.
4	Dialogue (Freedom)	I was able to talk freely with students from the other school during the oVice learning experience.
5	Dialogue (Freedom)	I was able to talk freely with students from the other school during the face-to-face learning session.
6	Dialogue (Initiative)	I was able to initiate conversations with students from the other school during the oVice learning experience.
7	Dialogue (Initiative)	I was able to initiate conversations with students from the other school during the face-to-face learning session.
8	Sharing Diverse Ideas	I was able to learn about different ways of thinking through dialogue during the oVice learning experience.
9	Sharing Diverse Ideas	I was able to learn about different ways of thinking through dialogue during the face-to-face learning session.

Results and Discussion

Results of the Questionnaire Survey for Children

Table 2 presents the findings of the questionnaire survey and those of the exact binomial test. In the category [Timing], all 25 respondents provided positive feedback, without negative responses, demonstrating a statistically significant difference (p = .0000, tow-tailed). One open-ended comment highlighted the advantage of face-to-face interaction, stating, "We were already familiar with each other because we had interacted in oVice beforehand." This indicates that all participating children viewed the metaverse as a beneficial preliminary step before engaging in face-to-face interaction within the exchange program. In the category [Dialogue (tension)], the responses for the metaverse were split, with 15 positive and 10 negative, showing no significant difference (p = .4244, two-tailed). Conversely, the face-to-face interaction received 22 positive and three negative responses, demonstrating a statistically significant difference (*p* = .0002, tow-tailed). One comment regarding the metaverse stated, "I didn't feel nervous because I couldn't see faces and only heard voices." These findings suggest that communication in the metaverse can help minimize unnecessary nervousness by reducing direct face-to-face exposure. In the category [Dialogue (degree of freedom)], the metaverse received 18 positive and seven negative responses, demonstrating a significant difference (*p* = .0433, tow-tailed), whereas the face-to-face setting received 16 positive and nine negative responses, showing no significant difference (*p* = .2295, tow-tailed). One child noted, "Even though we were far apart, we could still talk freely." This suggests that the metaverse facilitated more flexible and open communication compared to face-to-face interactions. In the category [Dialogue (initiative)], the metaverse received 17 positive and eight negative responses (*p* = .1078, tow-tailed), whereas the face-to-face setting had 12 positive and 13 negative responses (*p* = 1.0000, tow-tailed), with neither showing a significant difference. This suggests that, in both environments, not all children actively initiated conversations. In the category [Sharing diverse ideas], both the metaverse and face-to-face sessions recorded 20 positive and five negative responses, demonstrating significant differences in both cases (*p* = .0041, tow-tailed). One child remarked, "I realized the differences between Fukushima and Nagasaki because the environment we live in affects how we feel." These findings suggest that, in both settings, children were able to express themselves and engage in meaningful exchanges of diverse perspectives.

Table 2
Results of the Questionnaire Survey

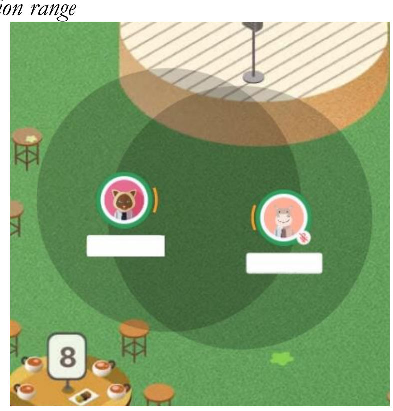
No	Category	Method	Positive	Negative	Exact Binomial Tests
1	Timing	Metaverse	25	0	**(*p*.<0.01)
2	Dialogue (Tension)	Metaverse	15	10	n.s.
3		Face-to-Face	22	3	**(*p*.<0.01)
4	Dialogue (freedom)	Metaverse	18	7	* (*p*.<0.05)
5		Face-to-Face	16	9	n.s.
6	Dialogue (Initiative)	Metaverse	17	8	n.s.
7		Face-to-Face	12	13	n.s.
8	Sharing various ideas	Metaverse	20	5	**(*p*.<0.01)
9		Face-to-Face	20	5	**(*p*.<0.01)

Results of Paper Interview for Teachers

Four key indicators were identified from the paper-based interview survey regarding how the teachers observed the children on the PC screen during the metaverse-based session: "signals during a call," "conversation range," "avatar movement," and "chat." "Signals during a call" refer to a visual cue emitted by an avatar when speaking through the microphone, a feature of oVice. Teacher A's remark, "Is there a signal coming from the avatar during the call?" suggests that this cue was monitored during observations. Figure 3 shows a scene about "Signals during a call." "Conversation range" refers to the visualized area where audio communication is possible, another feature of oVice. Teacher A stated, "I checked whether there was someone to talk to within the child's avatar's callable area," indicating that this range was used as an observational reference. Figure 4 shows a scene about "Conversation range." "Avatar movement" pertains to the motion of the students' avatars represented as icons. Teacher A mentioned, "I observed whether the children's avatars were moving around unnecessarily," whereas Teacher B stated, "I was watching the avatars' movements," both highlighting avatar motion as a monitoring factor. "Chat" refers to the chat display area visible within the metaverse environment. Teacher B remarked, "I was checking the children's conversations on the chat screen," indicating that chat content was used as an observation tool. Furthermore, Teacher A noted, "I couldn't grasp what kinds of exchanges were occurring in the children's voice conversations, but when I asked them to write in the chat, the interactions became visible and easier to understand." This suggests that chat functions can be particularly effective in metaverse settings where visual and auditory cues are limited. However, since "signals during a call" and "conversation range" are specific features of the oVice platform, they may not be available or observable in all metaverse environments. Meanwhile, Teacher A observed, "When the children checked the chat content, they didn't seem to understand the difference between [All] and [Mention], and they appeared unsure about where their messages were displayed. I felt that more explanation was necessary." This highlights the need for clearer explanations to enhance the effectiveness of chat-based interactions in the metaverse. Additionally, Teacher B reflected, "I should have divided roles among the teachers to better monitor how the children were doing." This suggests that pre-planned role allocation could improve support when multiple teachers are involved.

Figure 3.
Signals during a call

Figure 4.
Conversation range



Conclusion

Findings

This study explored distance learning in the metaverse, where children from different regions engaged in interactions and voluntarily exchanged ideas. As a result, the metaverse-based distance learning implemented in this study fostered a form of learning in which children from different regions shared their thoughts with one another of their own volition. In essence, it became clear that metaverse-based distance learning can be realized as a form of remote education where children share diverse ideas through voluntary and open dialogue. Additionally, The findings identified four key indicators: "signals during a call," "conversation range," "avatar movement," and "chat." This suggests that to ensure the success of metaverse-based distance learning, it may be necessary to focus on these four indicators and provide support as needed. These findings suggest that metaverse-based distance learning, with appropriate teacher support, has the potential to be as effective as, or even more effective than, face-to-face interactive learning. In other words, we were able to demonstrate the possibility of realizing the face-to-face learning style online in compulsory education, where children voluntarily seek out information and learn through active interaction with their peers. However, this study has certain limitations, as it was conducted over a short timeframe, focused on a single theme, and involved a small group of participants. Additionally, due to space constraints in this paper, only a portion of the collected data could be presented. Furthermore, it should be noted that "signals during a call" and "conversation range," which served as key observational indicators for the teachers during the sessions, are features specific to the oVice platform and may not be observable in all metaverse environments. Therefore, the findings should not be considered universally generalizable. Although previous research suggests that the integration of the metaverse into compulsory education is still in its early stages, the findings of this study hold exploratory value. Furthermore, since the current analysis relies exclusively on a perception-based survey using questionnaires, future studies should incorporate an examination of the actual content of the dialogues and the evolution of children's ideas. There is also room for further exploration of strategies to encourage more active and meaningful interactions among children in the metaverse.

Implications for Educational Practice

The findings of this study offer practical guidance for educators considering the implementation of 2D metaverse-based learning environments. To effectively integrate this innovative approach, several key aspects warrant focus. First, teacher preparation and training are essential. Comprehensive guidelines and professional development programs must be developed to ensure teachers are proficient in 2D metaverse functionalities, material creation tools, and effective pedagogical methods within virtual spaces. This should encompass not only technical skills but also teaching strategies that promote student engagement in virtual environments. Second, it is crucial to clearly define the technical infrastructure requirements and specifications supporting 2D metaverse-based learning. This includes detailed recommendations for necessary hardware (e.g., PCs, tablets), stable internet connectivity, and platform compatibility. Without a robust technical foundation, the learning experience can be significantly compromised. Third, age-appropriate considerations for various grade levels must be thoroughly examined. Content and interaction designs should align with students' developmental stages; for instance, younger students may benefit from more structured, guided experiences, while older students might thrive with more exploratory and autonomous learning opportunities. Fourth, the insights gained from this study also suggest potential applications to other subject areas. The interactive characteristics of 2D metaverses could be leveraged in diverse fields, such as collaborative projects, simulations, and role-playing scenarios. Finally, it is vital to proactively consider strategies for addressing common implementation challenges. These include troubleshooting technical issues, ensuring student privacy and security, and establishing frameworks to foster collaboration among educators. By adhering to these practical recommendations, educational institutions can maximize the potential of 2D metaverses, offering students richer and more engaging learning experiences.

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References

Damaševičius, R., & Sidekerskienė, T. (2024). Virtual worlds for learning in metaverse: A narrative review. Sustainability, 16(5), 2032.

Gorbunova, A., Lange, C., Savelyev, A., Adamovich, K., & Costley, J. (2024). The Interplay of Self-Regulated Learning, Cognitive Load, and Performance in Learner-Controlled Environments. Education Sciences, 14(8), 860.

Hatmanto, E. D., Pratolo, B. W., & Intansari, M. (2023). Metaverse magic: Unveiling the pedagogical potential and transformative effects on intercultural communication in English language teaching.

Ikeda, Y. (2015). COIL (Collaborative Online International Learning) as a Pedagogical practice for study abroad promotion (generating outward mindset through global peer learning). Research on Global Human Resource Development Education, 2(2), 65-70.

Inoue, K. (2021). Online Classes for Proactive, Interactive, and Deep Learning:A Study of Pedagogy in the Period for Integrated Studies During the COVID-19 Pandemic. *The Journal of Seigakuin University*, *33*(1/2), 123–137.

Kanamori, T. (2025). Speaking activities using the metaverse: The effect of avatars in alleviating anxiety in foreign language learning. Action Research Center for Language Education. Retrieved July 11, 2025, from https://www.arcle.jp/note/2024/0050.html

Kurata, S., Hoshino, Y., & Yamamoto, R. (2024). Development of learning design that amplifies self-regulation and peer interaction among elementary school students in a two-dimensional metaverse. *In The IAFOR International Conference on Education – Hawaii 2024 Official Conference Proceedings* (pp. 151–161).

Lin, M., Yoshida, H., Maruyama, N., & Suzuki, T. (2022). Advantages and challenges of international collaborative learning using the metaverse: Based on student reflections. Annual Report of the Center for Language and Culture Education, Tohoku University, 8, 78–86.

McClure, C., & Williams, P. (2021). Gather. town: An opportunity for self-paced learning in a synchronous, distance-learning environment. *COMPASS Journal for Learning and Teaching*, *14*(2), 1-19.

MEXT. (2020). Guidebook for utilizing remote education systems (3rd ed.). Retrieved July 11, 2025, from https://www.mext.go.jp/content/20210601-mxt_jogai01-0000

MEXT. (2023). GIGA school program x individualized optimal learning. Retrieved July 11, 2025, from https://www.mext.go.jp/studxstyle/special/51.html

MEXT. (2024). Study X Style – Special Feature 49. Retrieved July 11, 2025, from https://www.mext.go.jp/studxstyle/special/49.html

Nagahama, S., Watanabe, F., & Shigeta, K. (2023). Reviews and prospects for educational technology research on blended learning. *Japan Journal of Educational Technology*, 46(4), 601–616.

Onu, P., Pradhan, A., & Mbohwa, C. (2024). Potential to use metaverse for future teaching and learning. Education and Information Technologies, 29(7), 8893–8924.

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online university teaching during and after the Covid-19 crisis: Refocusing teacher presence and learning activity. Postdigital science and education, 2, 923-945.

Rini, F. K., Sa'diyah, H. M., Lula, D. A., Nur, H., Rabiatul, A., & Elvara, N. A. (2024). Distance learning implementation in Malaysian and Indonesian schools: Are city schools more superior to increase student independence? Pegem Journal of Education and Instruction, 14(3), 287–299.

Sato, T. (2019). The significance and methods of icebreakers in active learning classes (Doctoral dissertation, Tohoku University). Tohoku University Repository.

Sawasaki, T. (2023). Construction and practice of diverse learning environments using the metaverse. Research Report of the Japan Society for Educational Technology, 2023(2), 83–87.

Smart, J., Cascio, J., Paffendorf, J., Bridges, C., Hummel, J., Hursthouse, J., & Moss, R. (2007). A cross-industry public foresight project. In Metaverse Roadmap Pathways to the 3D Web (pp. 1–28).

Sriworapong, S., Pyae, A., Thirasawasd, A., & Keereewan, W. (2022, August). Investigating students' engagement, enjoyment, and sociability in virtual reality-based systems: A comparative usability study of spatial. io, Gather. town, and Zoom. *In International Conference on Well-Being in the Information Society* (pp. 140-157).

Tian, X., & Nonaka, Y. (2024). Effectiveness and challenges of synchronous collaborative remote teaching: Focusing on remote collaboration between Japanese and Chinese teachers. Journal of Educational Media Research, 30(2), 55–68.

Watanabe, Y. (2024). Learning Chinese in the metaverse. e-Learning Education Research, 18, 13–25.

Wu, Y., You, S., Guo, Z., Li, X., Zhou, G., & Gong, J. (2023, April). MR. Brick: designing a remote mixed-reality educational game system for promoting children's social & collaborative skills. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (pp. 1-18).