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The Benefits and Impact of Introducing a Metaverse World Creation Package in International Virtual Exchange

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Abstract. This study examines the impact of introducing the Metaverse World Creation Package (MWCP) in the "Multicultural Communication" course at Tohoku University. The implementation of MWCP significantly increased student participation in Metaverse world creation, rising from 35% to 100%, while the proportion of HMD-compatible worlds by students improved from 11% to 100%. Key features, particularly Grabbable objects and multimedia elements (Videos and background music), were identified as essential in enhancing presentation quality and audience engagement. Students highlighted increased interactivity, enriched cultural content, and improved HMD usability as areas for future development. The findings suggest that MWCP effectively mitigates technical barriers and fosters immersive learning experiences. Further refinements are needed to optimize its functionality, particularly in enhancing user interactivity and addressing sensory discomfort associated with HMD use.

Keywords: Extended Reality (XR), Metaverse World Creation Package, Audience Engagement, Virtual Exchange (VE).

1 Introduction

The rapid advancement of Extended Reality (XR) and Metaverse technologies is reshaping educational practices by providing innovative learning environments that transcend physical barriers. These technologies are especially valuable in the context of increasing globalization, enabling immersive cultural exchanges that foster intercultural understanding. By using three-dimensional virtual environments, students can enrich their cultural experiences beyond real-world constraints [1].

Tohoku University's International Virtual Exchange course leverages these technologies to facilitate cross-cultural interactions among domestic students, international students, and students from partner universities abroad. Previous studies have demonstrated that Metaverse worlds significantly improve intercultural understanding and audience engagement compared to traditional multimedia formats [2, 4, 16].

Prior research indicates that in surveys examining cultural understanding, the creation of Metaverse worlds received the highest evaluation [3], suggesting that increasing the number of content creators may enhance their learning outcomes. In classroom presentations, Metaverse worlds have been found to be the most effective for fostering intercultural understanding [4]. Moreover, the deployment of head-mounted displays (HMDs) was highly rated by students, implying that HMD-compatible Metaverse worlds can be highly useful in an academic setting[5].

The challenges of world creation—due to limited time, technical expertise, and support—may discourage students from engaging with these technologies. It is therefore necessary to examine whether the number of world creators, produced worlds, and HMD-compatible worlds can be increased under comparable resource conditions, and to reduce barriers for students deterred by these difficulties. Despite the benefits of Metaverse technologies, several challenges limit their effective use in education. Nearly all students, particularly those new to 3D content creation, struggle to build a Metaverse world within the limited class time (typically 4-5 hours). Technical challenges also arise when students create worlds from scratch. These environments often become too complex for standalone HMDs, leading to performance issues such as slow navigation and motion sickness.

In this course, students created their own Metaverse worlds on the VRChat platform for presentations and cultural activities, alongside the use of images, videos, and 360-degree videos. However, world creation demands high technical knowledge and time, prompting some students to choose easier multimedia options. Many encountered errors, and insufficient technical support further exacerbated the difficulty, especially in using HMDs for immersive experiences.

As an alternative, existing public Metaverse worlds were considered, but many were not HMD-compatible, had limitations on simultaneous users, and could not be customized to group needs. Furthermore, when existing worlds are absent, the content that can be conveyed is inherently limited, potentially constraining the presentation. Therefore, it is critical to establish an environment that allows for the easy creation of tailored worlds.

Considering these issues, it was necessary to develop an environment that facilitates efficient Metaverse world creation and HMD compatibility. Previously, students had to download various tools, risking errors due to complexity. In this class, the "Metaverse World Creation Package (MWCP)" was introduced, consolidating essential tools such as microphones and presentation screens into a single package with detailed usage instructions. The purpose of this paper is to assess whether the MWCP improves the world creation process and reduces technical challenges, based on metrics such as the percentage of students creating worlds, number of worlds created, and percentage of HMD-compatible worlds. For the MWCP, identifying the tools and features that are favorably received by audiences is crucial for determining which functionalities enhance engagement. Furthermore, by clarifying the preferred features of creators, this study aims to contribute insights for ongoing package refinement.

To address these issues, a specialized Unity package was developed for the Spring 2024 semester. This package simplifies Metaverse world creation for beginners and optimizes development for standalone HMD compatibility, streamlining tasks like 3D object placement, interaction setup, and navigation. By reducing technical challenges, it allows students to focus on content creation.

Given the underdeveloped instructional methods for Metaverse technologies, this study aims to identify key features that enhance learning outcomes and audience engagement, thereby improving instructional design and maximizing classroom time.

This study addresses the following research questions:

RQ1: Does the introduction of the MWCP increase the number of students participating in Metaverse world creation—measured by the percentage of students creating worlds, the total number of worlds created, and HMD compatibility—while addressing the technical and resource constraints observed prior to its implementation?

RQ2: What are the most effective features of the MWCP from the perspectives of both creators and the audience?

RQ3: How do students plan to improve their future Metaverse worlds, particularly regarding audience engagement, cultural relevance, and the use of HMDs usage?

By answering these questions, this study provides insights into optimizing Metaverse technologies for educational purposes, particularly in intercultural learning contexts, thereby informing future instructional design and support systems.

2 Literature Review

2.1 The Need and Benefits of Metaverse Technology in Intercultural Understanding

With globalization, educational programs that promote intercultural understanding have become essential [6]. However, traditional educational methods often struggle to provide authentic cultural experiences due to geographical and resource constraints. XR and Metaverse technologies have brought about innovations in new learning environments that can help address this issue [7]. These technologies transcend physical limitations, offering immersive experiences where students can interact with diverse cultures in virtual spaces [8].

The Metaverse provides a 3D virtual space that merges the real world with virtual elements, promoting realistic and immersive experiences [7]. Hayashi [4] explored how the use of Metaverse worlds influences the deepening of intercultural understanding compared to other multimedia tools, identifying critical features such as content interactivity, high levels of immersion, curiosity enhancement, realism, and autonomy over their own perspective. These features were found to play a significant role in facilitating deeper intercultural understanding by allowing users to experience different cultural contexts beyond the constraints of reality. Furthermore, Kabilan [9] suggests that the immersive nature of the Metaverse increases students' motivation and understanding, providing a platform for authentic cultural exchange. By enabling users to interact with content and engage with realistic environments, the Metaverse offers advantages over traditional multimedia tools in fostering meaningful intercultural interactions.

2.2 Challenges in Implementing Metaverse Technologies in Education

While XR and Metaverse technologies offer immersive environments for students to interact with different cultures, their implementation in education presents significant challenges, especially for novice users. Students with limited experience in 3D content creation may struggle to build virtual worlds within constrained time frames [10]. Additionally, limited support resources, such as teaching assistants, exacerbate these difficulties [11]. Ensuring smooth operation on standalone head-mounted displays (HMDs) further complicates the process [12].

Furthermore, many existing Metaverse world creation tools, such as Unity and Unreal Engine, are designed with professional developers in mind, leading to steep learning curves for students and educators who lack prior technical experience. These tools often require a solid understanding of programming, 3D modeling, or both, which can discourage adoption in educational contexts. In addition, the absence of intuitive interfaces and real-time support systems can hinder students' ability to effectively create and refine virtual environments within limited instructional time [13].

To overcome these challenges, it is essential to develop user-friendly tools. Albion [11] introduces the concept of "Low Threshold Applications," emphasizing the importance of easy-to-use development tools that require minimal technical expertise. Pre-designed packages, intuitive interfaces, and comprehensive instructional materials can significantly reduce the learning curve for beginners [14]. Lee and Hwang [10] report that even students with limited technical skills can improve their Information and Communication Technology (ICT) competencies through VR content creation and Metaverse activities, provided they receive structured guidance and support.

2.3 Enhancing Audience Engagement Through Metaverse Worlds

Audience engagement is a critical factor in effective learning within virtual environments. It is created through a combination of emotional connection, cognitive involvement, and active participation. Sood [15] emphasizes two primary dimensions of engagement: affective-referential involvement, which focuses on emotional resonance and personal relevance, and cognitive-critical involvement, which involves reflective and analytical thinking. These aspects highlight that engagement is more than mere preference; it involves a meaningful interaction with the content that supports deeper learning. In the context of the Metaverse, these dimensions are particularly important as they transform passive viewers into active participants, enabling immersive educational experiences.

Hayashi, et al. [16] compared various multimedia formats and found that Metaverse-based presentations were significantly more engaging than images, videos, and 360-degree videos. Applying "Task Engagement Principles" [17], the study demonstrated that interactive elements in Metaverse presentations greatly enhance engagement. These elements, like 3D objects and multimedia, foster dynamic educational experiences, promoting active participation and deeper intercultural understanding.

Collaborative activities in the Metaverse not only enhance technical skills but also foster research abilities and improve communication between students from different cultural backgrounds [18]. Through real-time interaction and joint content creation, students can overcome cultural differences and develop stronger teamwork skills [19]. Dreamson and Park [20] assert that designing spaces in the Metaverse allows students to engage in co-authorship, promoting deeper levels of collaboration, critical thinking, and intercultural understanding.

3 Methods

3.1 Participants and Group Organization

This study was conducted during the spring semester of 2024 in the "Multicultural Communication" course, with 34 undergraduate students from ten countries, including 18 Japanese students, eight international students, and eight overseas students. The students were divided into four groups, each with a unique theme. To promote diverse perspectives, each group included a mix of Japanese, international, and overseas students. Smaller teams of 2-3 members were formed within each group, ensuring at least one Japanese and one international or overseas student in every team to foster intercultural understanding.

3.2 Tools, Software, and World Creation Process

To assist with world creation, teaching assistants (TAs) were specifically asked to develop a Unity package under the instructor's guidance, drawing on insights from previous semesters. This package integrated essential functions, such as image, video, and music, as well as object manipulation and seating. It was designed to be user-friendly, ensuring that students with no prior experience could efficiently create their worlds within the allotted

class time. Unity 2022.3.6f1 and VRChat Creator Companion (VCC) were used to build the worlds on the VRChat platform. Photogrammetry was also provided to create detailed 3D models from photographs, allowing students to add realistic objects to their virtual worlds.

The course consisted of fifteen 90-minute lectures, where students were introduced to Unity and audience engagement principles. From the 6th to the 10th class, students focused on creating their Metaverse worlds, utilizing the Unity package and technical tools provided. Teaching assistants offered continuous technical support through tutorials and guidance, helping students overcome challenges and complete their projects efficiently.

The MWCP contains a template Metaverse world using Unity and VCC. It comes equipped with standard features that can be used to present in the world, along with slides explaining how to use these features. The MWPC includes the following: chairs the viewers can sit in, a microphone with a flag showing the location of the speaker, background music, a video player, a slide viewer, an object for displaying images, a teleportation function, and objects that can be held. All of these features were taken from those commonly used in previous classes and were selected because they could be easily included in a template. The template enables learners to use these functions by performing simple operations such as a few drags and drops while referencing the instructional slides. Without the package learners would have to find, install, and configure each individual tool on their own.

The abbreviations for the items in Fig. 2~6 are as follows: slide displays (Slides), image displays (Images), video displays (Videos), background music (BGM), audio playback (Audio), Grabbable 3D objects (Grabbable), microphone without a flag (Mic), microphone with a flag (MicFlag), chairs that can be sat on (Chairs), quiz answer area (Quiz), warp portal (Warp), others (Others), and not used – they didn't use any of the contents (Not used).

3.3 Data Collection and Analysis

At the end of the semester, a survey was conducted to collect both quantitative and qualitative data on the students' experiences with the MWCP. The survey asked students which features were most effective from both the creator's and audience's perspectives and what improvements they would suggest for future iterations.

For quantitative data, students ranked the most effective features, addressing RQ1 and RQ2 through numerical analysis. For qualitative data, open-ended questions were employed to explore students' insights on potential improvements, audience engagement, and HMD usage, specifically addressing RQ3.

The qualitative responses were analyzed using thematic analysis, following the method proposed by Matsukawa [21], allowing us to identify recurring themes and patterns in students' experiences. This mixed-methods approach provided a comprehensive understanding of how students interacted with the MWCP, enabling us to draw nuanced conclusions about both audience engagement and instructional design improvements.

4 Results

The results of this study were derived from a post-course questionnaire that addressed the research questions. Responses were included in the analysis if participants had submitted their answers by the deadline. A total of 25 valid responses were collected and analyzed to examine the effectiveness of the Unity-based MWCP. The following sections present the results according to RQ1, RQ2, and RQ3 (Chapter 1), each addressing the corresponding research question.

RQ1: Benefits of Introducing the Metaverse World Creation Package

The MWCP was introduced in the Spring 2024 semester to address challenges in Metaverse world creation. As a result of the implementation of the MWCP, the following outcomes were observed.

First, participation in world creation increased substantially. The percentage of students engaging in Metaverse world creation rose from 35% before the MWCP was introduced to 100% afterward. Similarly, the total number of creators doubled, increasing from 15 to 31 participants.

Second, there was a notable increase in the number of worlds created relative to the total number of participants. This ratio increased from 21% to 35%, reflecting not only an increase in productivity but also higher levels of engagement among students.

Third, the compatibility of created worlds with HMDs improved significantly. Prior to the introduction of the MWCP, only 11% of the worlds created by students were compatible with HMDs. Following the introduction of the package, this figure rose to 100%, enabling all participants to benefit from immersive learning experiences.

Table 1. Impact of Introducing the Metaverse World Creation Package (MWCP).

Semester	Participants	Participants who co-created a world	Percentage of participants who co-created a world	Worlds co-created	Ratio of worlds to participants	HMD-compatible worlds	HDM-compatible worlds by students	Percentage of student-made worlds that were HMD-compatible	MWCP introduction
2023 spring-1	40	2	5%	2	5%	2	1	50%	
2023 spring-2	40	6	15%	4	10%	3	0	0%	Before introduction
2023 fall	43	15	35%	9	21%	7	1	11%	
2024 spring	31	31	100%	11	35%	11	11	100%	After introduction

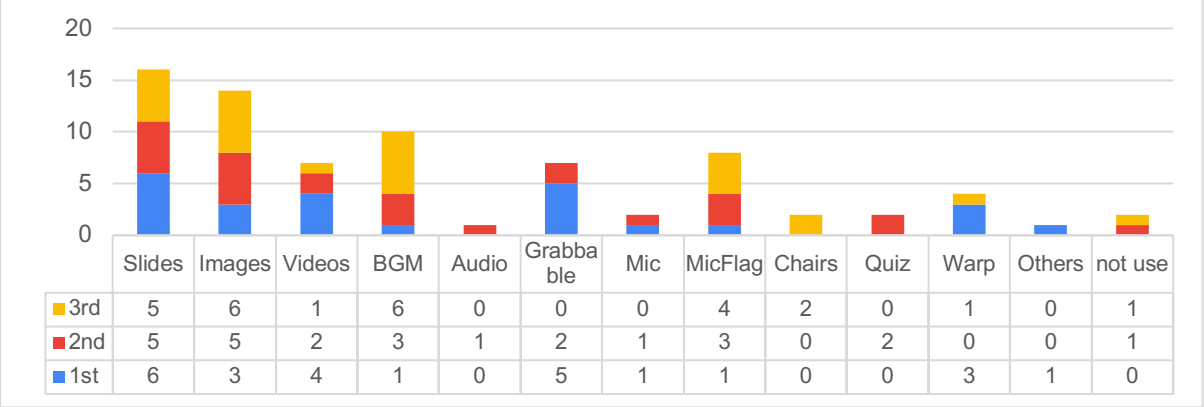
Importantly, these improvements were achieved without expanding instructional hours or increasing the number of teaching assistants. This demonstrates the efficiency of the MWCP in enhancing outcomes even within the constraints of limited educational resources.

Fig. 1. Examples of co-created Metaverse Worlds.

RQ2: Identifying the Most Effective Features of the Metaverse World Creation Package

RQ2-1 Top Features Identified in Students' Own Presentations. The survey asked students, "Which features did you find most effective when presenting in your own world? Please rank your top three choices." Fig. 2 illustrates the student rankings of the most effective features used in their own Metaverse presentations.

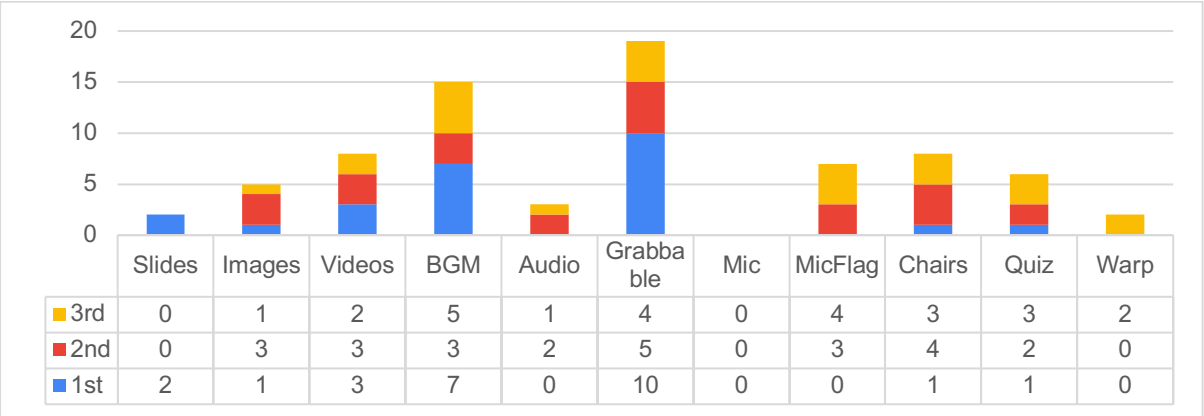
Slides received the highest number of first-place votes, with six students ranking it first, followed by Grabbable which was ranked first by five students, and Videos, which received four first-place votes. When considering total votes across first, second, and third places, Slides remained the most popular feature, with a total of 16 votes, followed by Images with 14 votes and BGM with ten votes.



	Slides	Images	Videos	BGM	Audio	Grabbable	Mic	MicFlag	Chairs	Quiz	Warp	Others	not use
3rd	5	6	1	6	0	0	0	4	2	0	1	0	1
2nd	5	5	2	3	1	2	1	3	0	2	0	0	1
1st	6	3	4	1	0	5	1	1	0	0	3	1	0

Fig. 2. Top-Ranked Features in Own Groups' Metaverse Presentations.

RQ2-2 Most Effective Features of the Metaverse World Creation Package as an Audience Member. In response to the question, "Among the features used in other groups' presentations, which did you find most effective? Please rank your top three choices," students highlighted several features as particularly effective (Fig. 3). Grabbable objects received the highest number of first-place votes, with ten students ranking it first, followed by BGM, which was ranked first by seven students, and Videos, which received three first-place votes. When considering total votes across first, second, and third places, Grabbable objects remained the most popular feature, with a total of 19 votes, followed by BGM with 15 votes and Videos with eight votes.

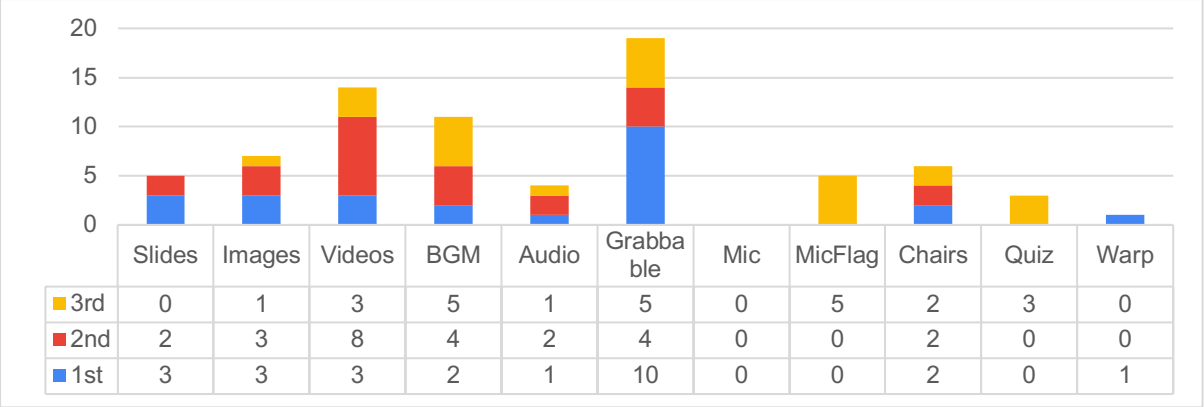


	Slides	Images	Videos	BGM	Audio	Grabbable	Mic	MicFlag	Chairs	Quiz	Warp
3rd	0	1	2	5	1	4	0	4	3	3	2
2nd	0	3	3	3	2	5	0	3	4	2	0
1st	2	1	3	7	0	10	0	0	1	1	0

Fig.3. Top-Ranked Features from Other Groups' Presentations.

RQ3: Future Improvements of the Metaverse World Creation Package for Audience Engagement and HMD Usage

RQ3-1 Desired Features for Future Metaverse World Creation. In response to the question, "If you were to create another world, which features would you definitely want to use? Please rank your top three choices," students identified several key features they would prioritize in future projects (Fig. 4). Grabbable objects received the highest number of first-place votes, with ten students ranking them first. This was followed by Videos, Images, and Slides, each ranked first by three students, and BGM and Chairs, which received two first-place votes each. When considering total votes across first, second, and third places, Grabbable objects remained the most popular feature, with a total of 19 votes, followed by Video with 14 votes and BGM with 11 votes.



	Slides	Images	Videos	BGM	Audio	Grabbable	Mic	MicFlag	Chairs	Quiz	Warp
3rd	0	1	3	5	1	5	0	5	2	3	0
2nd	2	3	8	4	2	4	0	0	2	0	0
1st	3	3	3	2	1	10	0	0	2	0	1

Fig. 4. Top Features Desired for Future Metaverse Worlds.

RQ3-2 Enhancing Audience Engagement and Cultural Understanding in Future Worlds. To explore how students planned to improve future Metaverse world creations, they were asked "With the goal of enhancing audience engagement and promoting understanding of different cultures, if you were to further improve your world, what aspects would you focus on? Please share your opinion." Responses were categorized into eight themes by Matsukawa [18], and the following five key themes emerged as the most significant areas for future improvement.

1) *Interactivity and Engagement.* Participants emphasized the need for greater interactivity through features like Grabbable objects and Quizzes, suggesting these would make the experience more engaging and encourage active audience participation.
2) *Cultural and Educational Content.* Students expressed a strong interest in adding more cultural and educational elements, such as regional traditions and storytelling, to deepen cultural understanding and provide richer experiences within Metaverse worlds.
3) *Multimedia and Visual Elements.* Respondents recommended incorporating more multimedia features, including Images, Videos, and BGM, to create a more immersive and visually appealing environment.
4) *Improving Audience Experience.* Several students proposed enhancing the interactivity and immersion of the worlds to better engage the audience and improve their overall experience.
5) *Concept and Content Expansion.* There was interest in broadening the thematic scope of Metaverse worlds by including a wider variety of events and cultural elements to enrich the experience.

RQ3-3 HMD User Feedback: Strengths and Areas for Improvement. To gather insights on how students felt using HMDs to experience Metaverse worlds, they were asked "After entering your own or your classmates' worlds using an HMD, please describe what you thought was good from the perspective of world creation, as well as what could be improved." Responses were collected from students who used HMDs during class, and 23 valid responses were analyzed.

1) *Interactivity and Engagement.* Once again, students emphasized the need for more interactive elements, such as Grabbable objects and Quizzes, to enhance engagement and immersion.
2) *Multimedia and Sensory Experience.* Students highlighted the importance of multimedia, especially BGM, for improving the sensory experience and creating a more immersive environment.
3) *Technical Usability and Improvements.* Technical issues, such as performance stability and brightness adjustments, were noted as key areas for improvement to ensure a seamless experience.
4) *Cultural and Educational Content.* Students expressed a desire to incorporate more diverse cultural elements and traditional features to enhance intercultural understanding within Metaverse worlds.
5) *Physical and Sensory Comfort.* Reducing physical discomfort, including motion sickness from using HMDs, was a major concern. Students suggested improvements to minimize dizziness and enhance overall comfort.

5 Discussion

RQ1: Benefits of Introducing the Metaverse World Creation Package

This study evaluated the effects of the MWCP on overcoming technical and resource-related barriers in Metaverse world creation, as identified in Chapter 1. The results demonstrate that the MWCP effectively facilitates world creation and supports immersive learning environments, with several key implications.

First, the rise in participation (from 35% to 100%), alongside the doubling of creators, indicates that the MWCP successfully reduced entry barriers for students previously deterred by the complexity of Metaverse world creation. This result is particularly significant given that these achievements occurred under comparable instructional hours and reduced TA support, demonstrating the MWCP's scalability in resource-limited settings.

Second, the increase in the ratio of worlds created (from 21% to 35%) suggests enhanced productivity and engagement among students. As noted in the literature (Chapter 2), immersive Metaverse environments are associated with deeper intercultural understanding and higher audience engagement [4, 16]. By facilitating the creation of more worlds, the MWCP contributes to a richer and more diverse cultural exchange experience, aligning with these findings.

Third, the increase in HMD-compatible worlds (from 11% to 100%) directly addresses prior challenges related to device compatibility and the need for external technical support. The MWCP simplified the process, enabling students—even those with limited technical expertise—to independently create fully functional worlds. This highlights the package's ability to reduce the reliance on external support while maintaining high-quality outcomes.

This demonstrates the package's potential for broader adoption in educational contexts, offering a scalable and cost-effective solution for implementing Metaverse technologies.

RQ2: Identifying the Most Effective Features of the Metaverse World Creation Package

The analysis of student feedback shows that interactive features and multimedia elements significantly enhance both presentation quality and audience engagement. Fig. 2 shows that Grabbable objects were ranked first by five students. This emphasizes the importance of interactive features in maintaining audience attention by providing a hands-on experience that makes the presentations more dynamic. This suggests that students prioritized interactive and visually impactful features over those that were primarily functional or auditory. Expanding on this, Fig. 3 highlights the broader impact of Grabbable objects on audience engagement, as they received the highest number of votes (19) and the highest proportion of first-place rankings relative to their total votes (53%). These findings underscore the significance of interactive elements in enhancing immersion by facilitating a transition from passive observation to active participation, ultimately fostering deeper engagement.

Grabbable objects received the second-highest number of first-place votes, yet ranked fifth in the total number of votes across first, second, and third places (Fig. 2). This discrepancy likely stems from the limited number of students who created Grabbable objects. Slide creation is a straightforward task; thus, nearly all students produced slides, resulting in a high number of creators. Conversely, creating Grabbable objects is a challenging task; consequently, only nine students created some. Nevertheless, the fact that five of these nine students selected them as their top choice, and that seven creators in total rated them as "Effective," suggests a positive evaluation of Grabbable objects, particularly when considering the small number of creators who assessed them.

Fig. 2 also suggests that students heavily relied on visual aids, likely perceiving them as the most effective tools for clear and engaging communication. Slides and Images were also highly valued for their ability to convey complex information concisely, offering clarity and structure. Meanwhile, BGM and Videos played a crucial role in creating an immersive environment by appealing to auditory and visual senses. BGM received the second highest number of votes (15) in Fig. 3. This suggests that BGM added emotional and sensory depth, increasing the overall immersion in the presentations. Videos were also ranked highly, demonstrating their role in storytelling and maintaining the audience's attention. These results indicate that multimedia elements added an immersive quality to the presentations.

Overall, students expressed a preference for features that improved the visual and experiential aspects of their Metaverse worlds, making them more engaging and immersive. This highlights the importance of balancing both traditional and interactive elements to optimize audience engagement.

RQ3: Future Improvements of the Metaverse World Creation Package for Audience Engagement and HMD Usage

For RQ3, we asked students which features they would like to incorporate in future presentations. Analyzing these responses can help instructors identify key content and features to prioritize in future iterations of the course. In particular, these findings can guide improvements to the MWCP and inform future instructional design.

Fig. 4 shows that Grabbable objects ranked first in both the number of first place votes and the total number of votes. This is consistent with the trend seen in Fig. 3, which asked about which features were popular for the other groups' presentations from the audience's perspective. On the other hand, this trend was not observed in Fig. 2, which asked about the functions popular among the presenters, indicating that it was the experience as an audience member that made them want to use Grabbable objects in the future.

While the positive audience experience made users want to use Grabbable objects in future presentations, this was not the case for second place and below. In Fig. 3, BGM is in second place and Videos are in third, but in Fig. 4, these results are reversed. This shows that both the audience and presenters preferred BGM more than Videos in the worlds they viewed, but for future worlds, they wanted to use Videos more than BGM. There are two main reasons for this.

As discussed in Chapter 1, Metaverse worlds exhibit higher audience engagement compared to other multimedia formats, such as Images and Videos. The principal distinction between Metaverse worlds and these other media lies in their ability to enable interactions with the virtual environment, for example, through the implementation of Grabbable objects or actions such as sitting on a chair. In Hayashi [4], many students indicated that the high degree of environmental interactivity is the key factor contributing to the enhanced depth of intercultural understanding afforded by Metaverse worlds relative to other multimedia. Moreover, Hayashi, et al. [16] reported that Metaverse worlds are highly valued for their capacity to promote active user engagement, which is expected to further elevate audience engagement.

Conversely, configuring 3D content to be both grabbable and interactive is considerably more challenging than merely placing 3D content within a Metaverse space. Nevertheless, the incorporation of Grabbable objects is anticipated to enhance learning outcomes. The introduction of the MWCP has facilitated the easier implementation of Grabbable objects. Consequently, it is expected that the adoption of the MWCP will confer advantages in terms of educational efficacy. It is crucial to further investigate this potential benefit in future research.

The first reason is the management of the presentation: BGM is, as the name suggests, the music playing in the background of the presentation, and it directly contributes to creating the atmosphere of the presentation. It does not require any special operation and does not interfere with the presentation in any way, either in terms of impact or operation. Videos, on the other hand, are more complicated to manage than BGM. The presenter must consider the necessary timing and operations required, and the audience is likely to evaluate it less highly if the presenter does not use it effectively. Conversely, these advantages and disadvantages can be reversed when it comes to audience impression. For example, the advantage of BGM not interrupting the presentation can be a disadvantage in that it fails to make an impact on the audience while Videos can be a great attraction for the audience if used appropriately. In Fig. 4, since students are asked to envision an ideal situation for their answers, BGM and Videos are reversed.

The second reason is a flaw in the design of the package. The current package is equipped with a video player that can only play one Video at a time; if students want to use multiple Videos, they must add several video players or implement a workaround on their own. This hurdle gave the presenters a sense that they could not utilize Videos effectively, while the audience had the impression that the Videos were not effective due to their limited presence However, this challenge may have motivated the presenters to overcome this systemic problem and introduce Videos in their next presentations. Based on this consideration, when developing the next package, we need to implement a mechanism that allows us to play two or more different Videos concurrently.

Regarding RQ3-2 and RQ3-3, students identified key areas for improvement, particularly in enhancing interactivity, cultural relevance, and HMD usability. There was a strong emphasis on using interactive features, like Grabbable objects and Quizzes, which were seen as essential for transforming passive audience experiences into active participation. This focus aligns with previous research highlighting the importance of interactivity for boosting engagement.

Cultural and educational content also emerged as a priority, with students expressing a desire to incorporate more diverse cultural elements such as regional traditions and storytelling. This suggests that future Metaverse projects could benefit from integrating structured cultural themes to promote deeper intercultural understanding.

Multimedia elements, including Images, Videos, and BGM, were identified as key tools for enhancing both the aesthetic and emotional depth of Metaverse worlds. These elements help maintain audience attention and contribute to the overall atmosphere, further enhancing engagement.

HMD usability issues, such as motion sickness and performance instability, were significant concerns. Students suggested improvements to technical features like brightness adjustment and system stability to enhance user comfort. These insights point to the need for ongoing technical refinements, particularly when using standalone HMDs, to ensure a smoother and more comfortable experience in the complex virtual environments.
Finally, students raised concerns about physical and sensory discomfort when using HMDs. Reducing the complexity of virtual worlds and optimizing the user interface for HMDs could help alleviate these issues, making the experience more accessible and enjoyable.

6 Conclusion

This study evaluated the impact of the Metaverse World Creation Package (MWCP) in addressing technical and resource-related barriers to Metaverse world creation. The findings demonstrate that the MWCP effectively facilitated world creation, allowing all students to successfully develop their own worlds while improving head-mounted displays (HMD) compatibility.

Additionally, the study examined the most effective features of the MWCP from the perspectives of both content creators and audience members. The results indicate that interactive features, particularly Grabbable objects, significantly enhanced engagement and immersion for both presenters and viewers. Multimedia elements, such as Videos and background music (BGM), were also highly valued for enriching sensory experiences. These findings highlight the importance of incorporating interactive and multimedia elements to optimize the user experience in Metaverse-based learning environments, reinforcing their potential as valuable tools for immersive education.

For future projects, students expressed a strong interest in enhancing the cultural and educational content, interactivity, and technical usability of their Metaverse worlds, particularly with regard to standalone HMDs. While HMDs offer significant immersive potential, feedback revealed ongoing usability challenges, including motion sickness and system performance issues, which must be addressed to fully leverage their educational benefits.

6.1 Limitations

A key limitation of this study is its relatively small sample size and its focus on a single course at one institution, which may limit the generalizability of the findings. The reliance on self-reported data introduces potential biases in students' assessments of their learning experiences. Furthermore, as Metaverse technologies continue to evolve rapidly, some of the technical challenges identified in this study may be mitigated in future iterations of the tools used.

6.2 Future Research Directions

To gain a more comprehensive understanding of the effectiveness of Metaverse-based learning, future research should involve a larger and more diverse group of students across multiple institutions to provide a broader perspective on its impact across different educational and cultural settings. Long-term studies would be particularly beneficial to observe how students' skills, engagement, and perceptions evolve as they gain more experience with Metaverse tools. Additionally, future research should explore the long-term effects of immersive learning on intercultural understanding and educational outcomes. Addressing technical and sensory challenges associated with HMD usage—such as improving system stability and minimizing discomfort—will be essential for maximizing the potential of Metaverse technologies in education.

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Notes. The Metaverse World Creation Package prepared for this class included a feature that allowed students to easily utilize "grabbable content." During the study, the term "Graspable 3D objects" was used as the English translation of this concept. However, since the actual functionality used by students was referred to as "Grabbable 3D objects," this paper adopts this term to ensure clarity and consistency for researchers in this field. It is important to note that the content created, utilized, and conceptualized by the students remains the same.

The MWCP introduced in this study was developed under Abe's initiative, based on the insights of Hayashi—the course instructor—and feedback gathered from reports and reflections submitted by participants during the first and second semesters of 2023. The essential functions to be incorporated into the package were carefully selected through discussions among Hayashi, Abe, and Hayama, and accordingly, Abe was responsible for its development. Meanwhile, data collection for this paper was carried out by Hayashi, and, with respondent anonymity maintained, the analysis and writing were conducted primarily by Hayashi and Hayama, with contributions from Abe and all three collaborators.

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