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# Low vs. High Immersion in Metaverse-Based Learning: How Pre-Service Teachers Balanced Between Instruction and Assessment in Learning Design

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**Abstract:** Emerging technology like the Metaverse has shown significant potential in expanding learning opportunities. This includes immersive environments, virtual student-teacher interactions, and diverse locations for learning and teaching. In particular, the Metaverse can enhance different modes of instruction and assessment, a crucial component of effective learning processes. This study explores how pre-service teachers design immersive learning environments through Metaverse-based learning. Eighteen pre-service teachers at a private university in Indonesia participated in a required course and were tasked with Metaverse-based learning projects. They worked in pairs and were divided into two groups. Four pairs designed learning in a low immersion Metaverse environment, while the other four pairs worked on a high immersion Metaverse environment. Their instructional and assessment strategies were graded using rubrics, and their project presentations were recorded for qualitative analysis. The findings revealed that engagement and interactivity, which facilitate understanding and application of learning objectives, were more aligned in the high immersion environment. Additionally, the quality of feedback, a key part of assessment, was rated higher in high immersion environments. From a qualitative perspective about the challenges in designing Metaverse-based learning, while high immersion environments offer advanced features that can enhance learning, they also present complexities that challenge the pre-service teachers' ability to manage and utilize these features effectively. Conversely, low immersion environments, although seemingly less technologically daunting, offer their own key challenges in terms of content integration and platform interconnectedness.

**Keywords:** immersion, learning design, metaverse learning, pre-service teachers.

## 1. Introduction

Preparing pre-service teachers through teacher education programs is crucial for shaping future education. While these programs are evolving, they face challenges in meeting the diverse needs of current learners. These learners, often referred to as digital natives, frequently engage with emerging technologies for highly interactive and virtual learning (Chen, 2023). Fraillon et al. (2020) stressed the importance of incorporating technology into teaching in this digital age. However, teachers' digital competence and instructional design often limit the integration of technology in instructional practices (See Basilotta-Gómez-Pablos et al., 2022; Chang et al., 2024). This competence extends to pre-service teachers' understanding of assessment for learning. Van Orman and Gotch (2024) suggest that teacher candidates should develop an understanding of assessment through personal affective, relational, and experiential encounters. They should focus on the quality of assessment and the extent to

which they use students' assessment results to inform and evaluate the teaching process (Kang & Anderson, 2015).

The Metaverse, where users, in this case is students, can engage with both real humans and virtual entities through virtual characters, has garnered much attention (Hwang & Chien, 2024). The Metaverse differs significantly from conventional virtual reality settings, particularly in users' experiences during multiplayer interactions. In the Metaverse, some environments are considered low immersion, and others high immersion. Low immersion environments typically feature simpler, two-dimensional graphics and are less sensory-engaging but still offer substantial interactive possibilities (e.g., Chang et al., 2024; Chen, 2023). In contrast, high immersion environments utilize 3D graphics and virtual reality technologies to mimic real-world interactions. They excel at creating a sense of presence in a three-dimensional space that behaves more like the physical world (e.g., Gómez & Figueroa, 2024; Sylaiou et al., 2024).

While some previous studies have successfully applied these technologies in various educational domains, no existing study compares low and high immersion Metaverse learning design by pre-service teachers. No study specifically examines their balance in adding instruction and assessment in Metaverse-based learning. This study proposes the following research questions:

1) In what ways do instructional strategies vary between low and high immersion metaverse learning environment as used by pre-service teachers?
2) In what ways do assessment strategies vary between low and high immersion learning environments as used by pre-service teachers?
3) What challenges do pre-service teachers face when integrating instructional and assessment strategies in low and high immersive metaverse settings?

## 2. Related work

### *2.1 The Metaverse-based learning*

Metaverse-based learning refers to a shared, immersive, and interactive virtual learning environment. In this setting, learners can connect virtually with avatars and participate in activities within the virtual space (Mystakidis, 2022). The metaverse concept emphasizes shared and interactive experiences in a virtual environment, presenting additional opportunities for educators to incorporate the metaverse in learning processes (Hwang & Chien, 2024; Zhang et al., 2022). As such, virtual experiences, and interactive activities within the Metaverse can boost learning engagement and, ultimately, improve learning outcomes (Gao et al., 2017).

Previous studies have explored the potential of low immersion metaverse environments to enhance learning outcomes. For example, Chang et al. (2024) used a low immersion Metaverse environment in nursing education, enhancing explicit instruction through self-regulation strategy as students explored the environment. The study discovered that students' learning outcomes, motivation, and self-efficacy were positively influenced by the low immersion Metaverse environment. Sylaiou et al. (2024), on the other hand, used a high immersion Metaverse environment for art exhibitions, where learners could create virtual exhibits by including digital artwork in a custom virtual space. High immersion Metaverse spaces can bridge the gap between physical learning and multimodal learning transactions, ushering in an era of boundless learning and teaching creativity with engaging and transformative learning experiences (Hurst et al., 2023).

To maximize the effectiveness of innovative instructional and assessment strategies, it is crucial to provide pre-service teachers with training on relevant learning design projects. Such training can enhance their skills in presentation and engagement by utilizing various Metaverse features, including spatial movement, content sharing, text-based chat, object interactions, and the use of expressive emojis (McClure & Williams, 2021; Zhao & McClure, 2022). Nonetheless, despite the potential benefits of the Metaverse for educational purposes, there remains a scarcity of research on how educators or pre-service teachers successfully implement teaching and assessment within this environment. Thus, this study seeks to offer

important insights into the pedagogical methods suitable for pre-service teachers in the Metaverse.

## 3. Research Methodology

### *3.1 Participants*

The study involved pre-service teachers (n = 16) from a private university in Java Island, Indonesia. These participants were taking a Digital Learning course and had no prior formal training in using or designing Metaverse or any immersive-based learning. The average age of the participants was 18.9 years, and all were taught by the same instructor. All participants were informed of the research objectives, procedures, and their rights before the study conducted. Based on their preliminary lesson plans, the participants were paired off and assigned to design metaverse-based learning with either low immersion, four pairs (n = 4) or high immersion, four pairs (n = 4).

### *3.2 Experimental procedure*

The topic of metaverse-based learning design was covered over five weeks, with each session lasting 100 minutes.

In the first week, pre-service teachers were introduced to learning design theories and the anticipated learning outcomes. They then worked in pairs to draft a lesson plan that integrated a subject domain topic with technology-based learning.

In the second week, the instructor gave feedback on each draft lesson plan and introduced instructional strategies for the technology-based learning model, including direct instruction and formative assessment. The participants also explored the metaverse environment through hands-on learning experiences. Those in low immersion pairs explored the Gather town platform (https://www.gather.town/), while those in high-immersion pairs explored the Spatial io platform (https://spatial.io/).

During the third week, each pair began designing their metaverse-based learning around their pre-lesson draft's subject domain topic. In the following week, they presented their metaverse-based learning and received feedback from instructors and peers. In the final week, each pair shared their final lesson plan and presented the metaverse-based learning.

As shown in Figure 1, each pair presented their metaverse-based learning project for at least 15 minutes. The figure's top part shows a low-immersion design implemented using Gather town, resembling a pixelated 2D video game like retro-style RPGs (Role-playing games) and depicting a conventional classroom. It features avatars for students and a teacher. Although this graphical style facilitates interaction and movement, it offers a basic virtual experience, hence its low immersion classification.

In contrast, the bottom part of the image shows a high-immersion learning environment designed in Spatial io. It features a more advanced and realistic 3D virtual space with a modern, circular meeting area surrounded by multimedia screens displaying content and interactive elements. The avatars are detailed 3D renderings, supporting interactions and enhancing the sense of virtual presence. This design aims to create a deeply immersive experience through detailed environments and realistic avatar interactions, offering an engaging and lifelike educational experience, hence its high immersion classification.

Figure 2 illustrates the features that pre-service teacher incorporated into a low-immersion, metaverse-based learning environment using the Gather town platform. In the top-left panel (see Figure 2a), explicit instructions were provided in the virtual classroom through visual cues like arrows. They guided students through the environment, highlighting areas of interest or action, such as workstations or information boards. This simplifies navigation and task sequences, making it easier for students to understand their next steps. In the top-right panel (see Figure 2b) displays a sample of the available learning materials. A document or presentation on the screen provides detailed information on a specific subject, in this case, human organs. The information is structured and integrates text with visual elements, enhancing student comprehension and engagement.

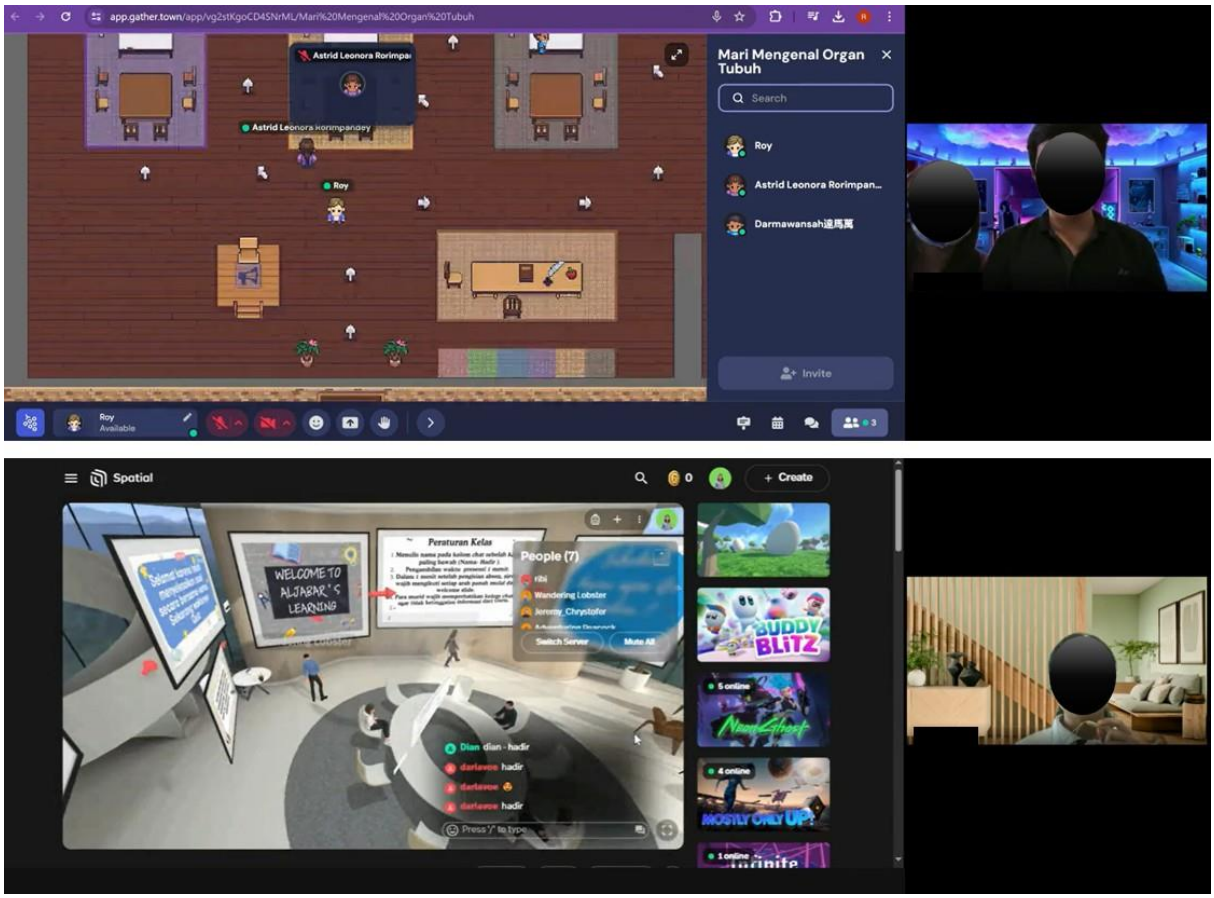


*Figure 1.* The pre-service teachers presented their low (top) and high (bottom) immersion metaverse-based learning design

The bottom-left panel (see Figure 2c) shows an example of audiovisual content knowledge, demonstrating the use of multimedia to enrich the learning experience. The content includes animated videos that explain complex concepts in a visually engaging and simplified manner. It is to maintain student interest and catering to varied learning preferences, breaking down complex information into digestible chunks. Finally, the bottom-right panel (see Figure 2d) shows a type of formative assessment used within the environment. It includes a quiz with multiple-choice questions that let students test their understanding of the covered material. This assessment tool provides instant feedback, and allows teachers to assess the effectiveness of the instructional content.

Figure 3 highlights various added features of the high-immersion metaverse-based learning environment. This environment, designed by pre-service teachers using the Spatial.io platform. The top-left panel (see Figure 3a) depicts a sample learning space and online chat functionality within the platform. It shows a modern, 3D virtual meeting room with large interactive screens and a circular seating arrangement. This encourages a collaborative learning atmosphere. The avatars are engaged in online chat, illustrating real-time communication capabilities that promote interaction and discussion.

The top-right panel (see Figure 3b) presents a learning survey form on a virtual whiteboard. This tool collects feedback or conducts surveys within the learning environment, simplifying the process of gathering learner insights. This integration of interactive forms streamlines the feedback loop and aligns with other learning activities, ensuring an adaptive educational process. The bottom panel (see Figure 3c) emphasizes the integration of audiovisual content, particularly in a music learning context. The virtual piano and instructional videos create an immersive learning experience. This allows students to interact with musical concepts in a visually intuitive way.

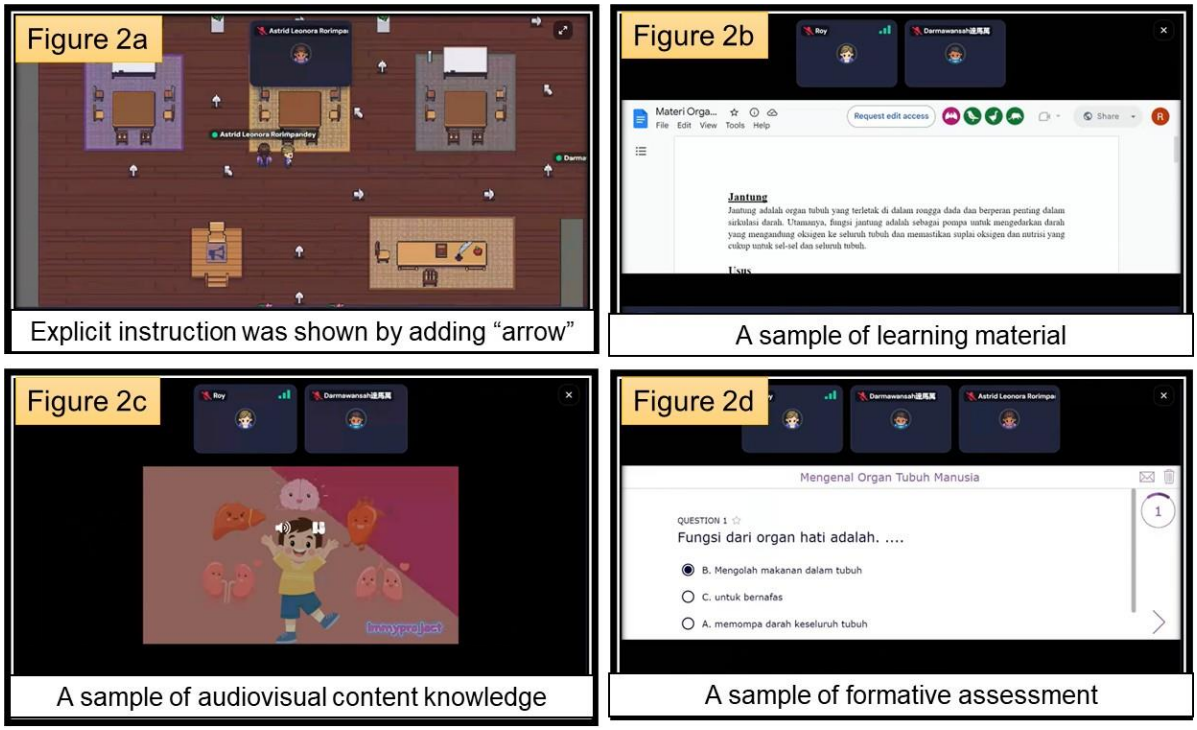


*Figure 2.* The sample of added features of pre-service teacher’s learning design in the low immersion metaverse-based learning.

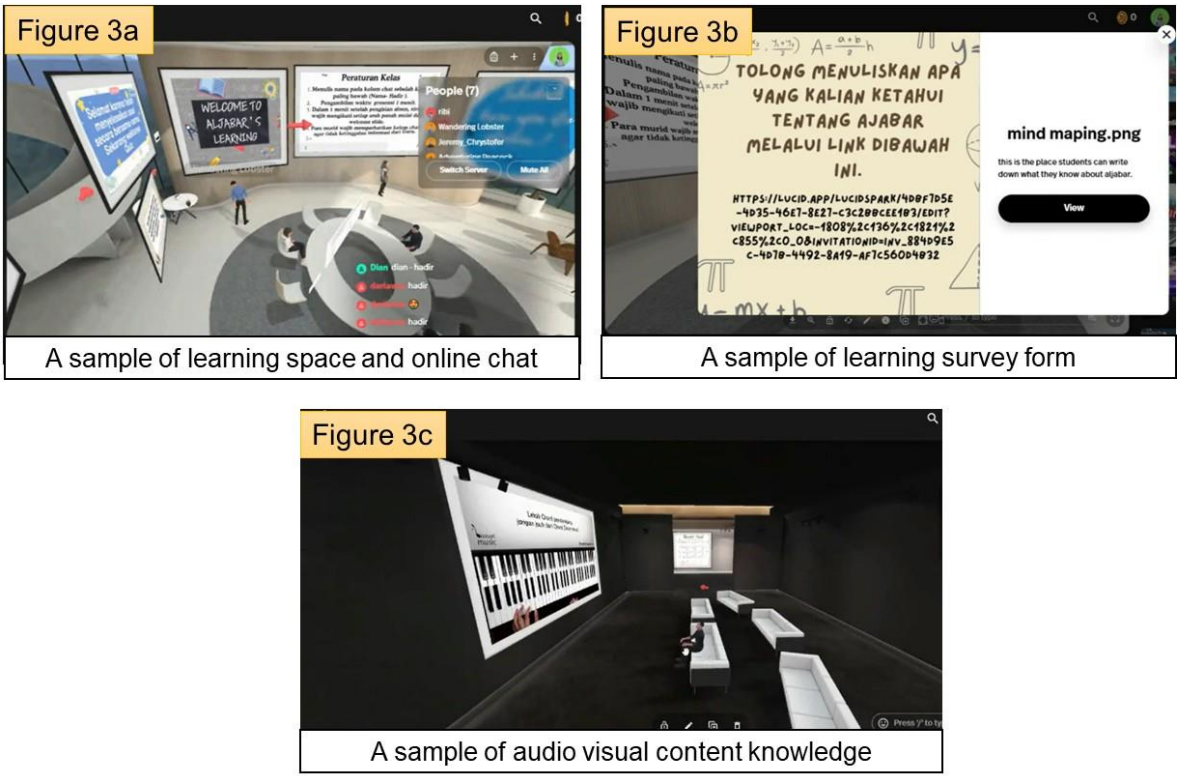


*Figure 3.* The sample of added features of pre-service teacher’s learning design in the low immersion metaverse-based learning.

### *3.3 Measuring tool*

The metaverse-based learning projects of pre-service teachers were evaluated using rubrics. These rubrics were composed of five criteria to judge the instruction and four criteria for the

assessment. The first 4-scale rubric assessed clarity of instruction, engagement and interactivity, alignment with learning objectives, facilitation of understanding and application, and the use of metaverse features. The second 4-scale rubric evaluated the integration with metaverse technology, measurement of learning outcomes, quality of feedback, and the use of innovative assessment strategies. Two researchers and an instructor designed and graded these projects. They achieved a Kappa value of 0.753, indicating a reasonable level of agreement.

During the presentation, each pair was asked to share their experiences and challenges encountered during the project. These presentations were recorded and subject to qualitative analysis. The challenges of each project were transcribed and examined through thematic analysis.

## 4. Findings

### *4.1 The instruction strategies between low and high immersion metaverse learning environment*

Regarding the grading results shown in Table 1, the Mann–Whitney U test, a non-parametric statistical method, was utilized due to the small size of the study sample. Additionally, the Shapiro–Wilk test verified that our sample was not normally distributed. According to Table 1, the results from the Mann–Whitney test indicated that the high-immersion metaverse learning environment was more engaging and interactive (Mdn = 3) than the low-immersion environment (Mdn = 3), with U = .50, z = − 2.291, p =.022, and r = 0.8.

In terms of how well the activities aligned with learning objectives, the pre-service teachers in the high-immersion metaverse environment (Mdn=4) received higher scores than those in the low-immersion environment (Mdn=4), with U = 2.00, z = − 2.049, p = .04, and r = 0.7. The high-immersion environment also outperformed the low-immersion environment in the effective use of metaverse features (Mdn=3), with U = 1.00, z = -2.124, p = .03, and r = 0.7.

However, when it came to the clarity of instructions, and the facilitation of understanding and application, there was no difference between the low-immersion (Mdn = 3.3) and high-immersion (Mdn = 3.3) environments, as they were similarly designed by pre-service teachers, with U = 5.00, z = − .949, and U = 4.50, z = − 1.323, respectively.

Overall, these findings suggest that while high immersion metaverse environments offer superior user engagement, alignment with learning objectives, and feature utilization, the fundamental educational tasks of providing clear instructions and facilitating understanding do not inherently benefit from higher immersion level, compared to the low immersion Metaverse environment.

Table 1. *The Mann-Whitney U test result for the instruction features of the low and high immersion metaverse learning environment*

| Criteria | Condition | *N* | Mean-Rank | Sum of Ranks | *U* | *z* | r |
|---|---|---|---|---|---|---|---|
| Clarity of instruction | Low immersion | 4 | 3.75 | 15.00 | 5.00 | - .949 | |
| | High immersion | 4 | 5.24 | 21.00 | | | |
| Engagement and interactivity | Low immersion | 4 | 2.63 | 10.50 | .50 | -2.291* | 0.8 |
| | High immersion | 4 | 6.38 | 25.50 | | | |
| Alignment with learning objectives | Low immersion | 4 | 3.00 | 12.00 | 2.00 | -2.049* | 0.7 |
| | High immersion | 4 | 6.00 | 24.00 | | | |
| Facilitation of understanding and application | Low immersion | 4 | 3.63 | 14.50 | 4.50 | -1.323 | |
| | High immersion | 4 | 5.38 | 21.50 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Use of metaverse features | High immersion | 4 | 2.75 | 11.00 | 1.00 | -2.124* | 0.7 |
| | Low immersion | 4 | 6.25 | 25.00 | | | |

### *4.2 The assessment strategies between low and high immersion metaverse learning environment*

The grading results were evaluated using the Mann–Whitney U test, a non-parametric statistical technique, appropriate due to the study's limited sample size. The Shapiro–Wilk test also confirmed a non-normal distribution of our sample. According to the results displayed in Table 2, the Mann–Whitney test showed a preference for the feedback quality in the high immersion metaverse learning environment (Mdn = 3) over the low immersion environment (Mdn = 3), with U = 2.00, z = −2.00, p = .04, and r = 0.7.

However, the application of assessment strategies by pre-service teachers was consistent across both low and high immersion metaverse learning environments for other evaluated criteria. For instance, in terms of integrating technology, the assessment integration by pre-service teachers was similar in both low (Mdn = 3) and high (Mdn = 3) immersion environments, evidenced by U = 3.00, z = −1.667. Similarly, in measuring learning outcomes and employing innovative assessment strategies, pre-service teachers utilized comparable approaches in both low (Mdn = 3.3) and high (Mdn = 3.3) immersion environments, with U values of 3.00, z = −1.667, and 2.00, z = −1.858, respectively.

In conclusion, while high immersion metaverse learning environments enhance certain aspects of the assessment experience, such as feedback quality, they do not necessarily alter the core methods and strategies used by pre-service teachers for assessment. This finding underscores the importance of focusing not just on the immersive quality of the learning environment but also on the pedagogical approaches, choosing effective assessment, employed within these technological frameworks.

Table 2. *The Mann-Whitney U test result for the assessment strategies of the low and high immersion metaverse learning environment*

| Criteria | Condition | *N* | Mean-Rank | Sum of Ranks | *U* | *z* | r |
|---|---|---|---|---|---|---|---|
| Integration with metaverse technology | Low immersion | 4 | 3.25 | 13.00 | 3.00 | - 1.654 | |
| | High immersion | 4 | 5.75 | 23.00 | | | |
| Measurement of learning outcomes | Low immersion | 4 | 3.25 | 13.00 | 3.00 | -1.667 | |
| | High immersion | 4 | 5.75 | 23.00 | | | |
| Feedback quality | Low immersion | 4 | 3.00 | 12.00 | 2.00 | -2.000* | 0.7 |
| | High immersion | 4 | 6.00 | 24.00 | | | |
| Use of innovative assessment strategies | Low immersion | 4 | 3.00 | 12.00 | 2.00 | -1.858 | |
| | High immersion | 4 | 6.00 | 24.00 | | | |

### *4.3 The challenges do pre-service teachers face when integrating explicit instruction and assessment in low and high immersive metaverse settings*

Table 3 presents a qualitative analysis of the challenges pre-service teachers encounter when designing metaverse-based learning environments, categorized by low and high immersion settings. The findings illustrate that these difficulties shift based on the immersion level in metaverse technology.

"Creativity in teaching" surfaced as a constant challenge in both low and high immersion contexts, appearing equally in each environment. This implies that pre-service teachers, irrespective of immersion depth, grapple with incorporating creative teaching methods effectively. "Interconnected platforms" was another substantial struggle, reported more frequently in low immersion settings as opposed to high immersion. This indicates that establishing a unified learning experience via multiple platform integration is harder in low

immersive environments, potentially due to less integrated, simpler technologies that lack seamless communication.

The challenges "Content added features" and "Technology's complexity" were more noticeable in low immersion contexts. This suggests that high immersion environments, despite their inherent complexity, may have a design that better facilitates content feature integration. On the other hand, low immersive settings might lack the robustness required for smooth content addition, rendering the integration process more taxing.

High immersion environments faced more "In-class vs. in-metaverse interaction" challenges than low immersion. The higher number in high immersion could point to heightened expectations and interaction potential within more intricate environments, emphasizing the difficulty of maintaining effective communication and engagement in these advanced virtual settings.

In conclusion, these insights suggest that while high immersion environments provide sophisticated features that can augment learning, they also introduce complexities that test the pre-service teachers' capacity to manage and use these features effectively. Conversely, while low immersion environments might appear less intimidating from a technological standpoint, they pose their own distinctive challenges concerning content integration and platform interconnectivity.

Table 3. *Qualitative analysis of the students' challenges in designing metaverse-based learning*

| Theme | Code | The number of occurrences | |
|---|---|---|---|
| | | Low immersion | High immersion |
| Designing appropriate instruction and learning strategies | Unfamiliar learning strategies | 2 | 3 |
| | Creativity in teaching | 5 | 5 |
| | Teaching quality through metaverse environment | 6 | 4 |
| | In-class vs. in-metaverse interaction | 9 | 11 |
| | Learning timing | 4 | 5 |
| Using specific features in the metaverse technology | Shareable link to users | 5 | 5 |
| | Technology's complexity | 3 | 4 |
| | Content added features | 8 | 6 |
| | Interconnected platforms | 8 | 3 |

## 5. Discussion and Conclusion

In this study, we examined how pre-service teachers balanced instruction and assessment strategies in low and high immersion Metaverse environments. The findings indicated that specific instruction and assessment strategies were ranked higher in high immersion environments.

High immersion Metaverse learning environments significantly increased user engagement and interactivity compared to low immersion environments. This suggests that high immersion environments, due to their more interactive virtual experiences, are more effective at captivating learners. These environments may also improve learning outcomes that align with instructional goals, possibly through more engaging instructional methods that enhance learning absorption and retention. However, both low and high immersion environments performed equally well in terms of instruction clarity and understanding and application facilitation.

In terms of assessment strategies, high immersion environments provided superior feedback quality. This could be due to the more interactive and engaging tools in immersive environments which can provide detailed and responsive feedback to learners. However, there was no significant difference in the integration with Metaverse technology, the measurement of learning outcomes, and the use of innovative assessment strategies across the two environments. This suggests that the fundamental assessment strategies remain consistent,

regardless of the technological advancement and immersive experience provided by high immersion platforms.

The qualitative analysis revealed various challenges when designing learning experiences in different Metaverse settings. High immersion environments, although rich in features, require careful management. Low immersion environments, despite being less technologically complex, still require significant attention to integration and content delivery. This understanding is crucial for pre-service teachers, educators, and instructional designers aiming to optimize Metaverse-based learning platforms.

Despite the critical discussions in this study, there are some limitations. First, our sample was limited in number and type, potentially affecting the findings. Second, we did not discuss in-depth the specific added features of instruction and assessment in the Metaverse environment which could benefit readers, particularly practitioners. Lastly, we did not investigate the evolution of pre-service teachers' lesson plans. Further studies are encouraged to examine the relationship between pre-service teachers' lesson plans and the final Metaverse-based learning design.

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