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Metaverse vs Classroom: A Quasi-Experimental Study on Learning Digital Business and Creative Skills

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ABSTRACT

To address the need for practical skills in the creator economy era, this study evaluates the comparative effectiveness of Metaverse Based Learning, Online Learning, and Blended Learning models on students' cognitive competence. This study fills a crucial research gap by providing a quasi-experimental comparison within a developing country context, where technical constraints are a critical variable. Employing a mixed-methods approach anchored in a quasi-experimental pretest-posttest non-equivalent control group design (N = 90), data were collected using a validated cognitive competency test (α = 0.796) administered as a pre/post-test, supplemented by participant observation and semi-structured interviews. Quantitative data were analyzed using N-Gain and ANCOVA, while qualitative data were analyzed thematically. The results revealed a paradox: quantitatively, there was no statistically significant difference (p = .376) among the groups, with all models proving equally effective (N-Gain "High" category). However, qualitative findings consistently revealed that Metaverse Based Lerning was fundamentally superior in fostering interaction, active participation, and spontaneous creativity not observed in the other groups. The implication is that while all three models are equivalent for standard knowledge acquisition, Metaverse Based Learning offers a far superior potential for developing active and creative learners, a potential that was likely suppressed by technical constraints and not captured by the standard cognitive test.

Keywords: Metaverse Based Learning; Quasi-Experimental Design; Second Life; Blended Learning; Online Learning.

ABSTRAK

Penelitian ini menjawab kebutuhan akan keterampilan praktis di era ekonomi kreator, tujuan penelitian ini adalah untuk mengevaluasi efektivitas komparatif dari model Metaverse Based Learning, Online Learning, dan Blended Learning terhadap kompetensi kognitif mahasiswa. Penelitian ini mengisi kesenjangan riset krusial dengan menyediakan perbandingan kuasi-eksperimental dalam konteks negara berkembang, di mana kendala teknis menjadi variabel penting. Menggunakan pendekatan mixed-methods dengan jenis penelitian kuasi-eksperimental (N = 90), data dikumpulkan menggunakan instrumen tes kompetensi kognitif yang tervalidasi (α =0.796) sebagai pre/post-test, serta didukung oleh observasi partisipatif dan wawancara semi-terstruktur. Analisis data kuantitatif menggunakan N-Gain dan ANCOVA, sementara data kualitatif dianalisis secara tematik. Hasil penelitian menunjukkan sebuah temuan: secara kuantitatif, tidak ada

perbedaan statistik yang signifikan (p = .376) antar kelompok, dengan semua model sama-sama efektif (N-Gain kategori "Tinggi"). Namun, temuan kualitatif secara konsisten menunjukkan Metaverse Based Learning secara fundamental superior dalam menumbuhkan interaksi, partisipasi aktif, dan kreativitas spontan yang tidak teramati pada kelompok lain. Implikasinya adalah bahwa meskipun ketiga model setara untuk akuisisi pengetahuan standar, Metaverse Based Learning menawarkan potensi yang jauh lebih unggul untuk mengembangkan pembelajar yang aktif dan kreatif, sebuah potensi yang kemungkinan terhambat oleh kendala teknis dan tidak tertangkap oleh tes kognitif standar.

Kata kunci: *Pembelajaran Berbasis Metaverse; Desain Kuasi-Eksperimental; Second Life; Pembelajaran Blended; Pembelajaran Daring.*

A. INTRODUCTION

The metaverse has driven significant transformations in both the technological and global economic spheres. Current literature confirms that the metaverse is no longer merely a concept but rather an ecosystem supported by continuously evolving technologies (Gao et al., 2024) and (Nguyen et al., 2024), presenting both various challenges and tangible applications (Peng et al., 2024). This transformation reinforces the growth of the creator economy (Peres et al., 2024) and has a significant sociological impact (Pradan, 2023). This development aligns with various Sustainable Development Goals (SDGs), such as “Quality Education,” “Decent Work and Economic Growth,” and “Industry, Innovation, and Infrastructure,” which necessitates a new paradigm in education (Hussain, 2023). To achieve these SDGs, higher education institutions are required to prepare students with hybrid skills “a combination of creative abilities and digital business competencies” that are relevant to the challenges and opportunities of this new era (Latif et al., 2024; Prasetyo & Sutopo, 2018).

Numerous international studies indicate that learning through the metaverse is often conducted on pioneering platforms such as Second Life. Warburton (2009) thoroughly identified the unique affordances of Second Life, such as the enhancement of social presence, immersive collaboration, and experiential learning. Concurrently, Inman, Wright, & Hartman (2010), through their research review, affirmed that the platform has been consistently proven to increase student motivation and engagement. The scale of this platform's adoption in international education is notably significant. A report from the New Media Consortium (NMC) in 2007 indicated massive participation, with over 300 universities having established a presence in Second Life for teaching or research purposes (Johnson et al., 2007). Data from the United Kingdom is even more compelling, where a study by Kirriemuir (2008) found that over 80 percent of universities had experimented with Second Life, while its economy continues to operate independently and is monitored by Linden Lab (2023).

Table 1. Comparison of Second Life Case Studies at Various Universities

University/Study	Field of Application	Form of Use in Second Life	Key Outcomes/Findings
Warburton (2009)	General Higher Education	Review of Second Life implementation in hundreds of universities	Potential for social presence, collaboration, experiential learning
Inman, Wright, & Hartman (2010))	K-12 & Higher Education	Review of Second Life case studies in schools & universities	Increased motivation & engagement
The Open University (UK)	Distance Education	Virtual campus: classrooms, exhibitions, forums	Increased social interaction among distance learners
Harvard University	Law / Negotiation	Mock trial simulations, virtual negotiations	Improved student legal & communication skills
INSEAD	Business / Management	Global business simulations, virtual company management	Improved decision-making & international collaboration

Although international empirical evidence demonstrates the significant potential of virtual worlds, their adoption within the Indonesian higher education landscape remains markedly limited. This reflects broader, persistent challenges in optimizing digital learning, where even standard online and blended models still struggle with issues of student engagement and infrastructure post-pandemic (Rasmitadila et al., 2020). This gap is confirmed by preliminary studies on institutional readiness for the metaverse itself (Yudhanto et al., 2023). This limitation is crucial amidst current economic challenges. Therefore, this study argues that the utilization of platforms like Second Life is not merely a pedagogical innovation but a strategic necessity.

The primary hypothesis of this study is that Metaverse Based Learning will yield a greater increase in competence compared to Blended Learning and Online Learning. This assumption is based on the premise that immersive 3D virtual environments provide unique learning affordances, such as an enhanced sense of presence, engagement, and motivation (Dalgarno & Lee, 2010). The theoretical framework of this study is built upon the foundation of Situated Learning Theory (Lave & Wenger, 1991), which posits that learning is most effective when it occurs within an authentic context of practice. This theory has been validated in modern technological contexts, where the design and evaluation of web-based virtual reality simulations are increasingly centered on providing authentic, situated learning experiences (Liaw et al., 2020), sebuah topik yang menjadi pusat perhatian dalam tinjauan sistematis terbaru tentang metaverse di pendidikan formal (Shi & Park, 2024). This theory has been extensively reviewed and validated in various literature (Shahrin, 2016), where studies indicate its positive correlation with learner performance (Zheng, 2010), its effectiveness in teacher preparation programs (Bell et al., 2013), and its ability to facilitate the transfer of knowledge to real-world applications (Catalano, 2015). This approach is complemented by the Revised Bloom's

Taxonomy to encourage the attainment of higher-order competencies (Krathwohl, 2002), karena lingkungan belajar virtual reality telah terbukti secara efektif mendukung pengembangan kognitif siswa (Chen, 2016). To ensure the instructional design does not impose an excessive cognitive load on students, the principles of Cognitive Load Theory (Sweller, 1994) are also integrated. Managing cognitive load is a foundational element in designing effective game-based and virtual environments (Wu, B., Yu & Gu, 2020), ensuring the design does not overwhelm students (Sweller et al., 2019) while allowing for the occurrence of productive failure as part of a deep learning process (Kapur, 2016).

Theoretically, this study contributes to the literature on immersive learning, but its primary novelty lies in moving beyond descriptive case studies or broad meta-analyses. This research provides a rigorous quasi-experimental comparison of Metaverse Based Learning against both Blended and Online models simultaneously. While numerous meta-analyses (Li & Yu, 2023; Liang et al., 2023; Sripan & Lertlutersirikul, 2025; Jusuf et al., 2023; Kim et al., 2023), confirm the general potential of the metaverse, they often lack granular, comparative data. This study addresses that gap by providing direct empirical evidence within the specific and under-researched context of Indonesian higher education, testing the practical application of these models amidst the unique institutional and infrastructural challenges identified by Yudhanto et al. (2023). Practically, this research aims to provide data-driven recommendations for stakeholders, moving from theoretical potential to evidence-based implementation.

B. RESEARCH METHOD

This study employed a quasi-experimental design using a pretest-posttest non-equivalent control group model. This approach was selected as the most appropriate method for making causal comparisons within pre-existing class contexts where random assignment is not feasible (Creswell & Creswell, 2018; Shadish et al., 2002). This design is a common and rigorous method used in applied research to evaluate interventions when randomized trials are not practical (Reeves & Wells, 2017). The experiment was structured using the PICO framework to formulate a systematic and testable research question (Schardt et al., 2007; (Eriksen & Frandsen, 2018).

Table 2. PICO Framework

Component	Description
Population	Digital Business students undertaking the Economics and Digital Business course.
Intervention	Application of a Metaverse Based Learning approach for the practical session, featuring immersion within the creator economy of the Second Life virtual world.
Comparison	Other learning models, namely: 1. Blended-Learning Model. 2. Online Learning Model.
Outcome	An increase in student competency scores post-treatment, measured by a post-test which encompassed two main aspects: an improvement in Creative Skills, defined as basic 3D building ability, and an improvement in Digital Business Competence, defined as the understanding of business strategies in a virtual market.

The research participants were 90 students selected using a purposive sampling technique, which is a common and justified method for selecting specific groups in applied research (Etikan et al., 2016; Campbell et al., 2020). The sample was then evenly divided into three treatment groups. Data were analyzed using two techniques. To test the hypothesis, an Analysis of Covariance (ANCOVA) was employed, with the post-test score as the dependent variable and the pre-test score as the covariate, following established statistical procedures (Field, 2013; Tabachnick & Fidell, 2013). This use of ANCOVA is a standard practice for enhancing statistical control in quasi-experimental educational studies (Casinillo & Fuentes, 2025). To measure the magnitude of learning improvement, the Normalized Gain (N-Gain) calculation was used (Hake, 1999).

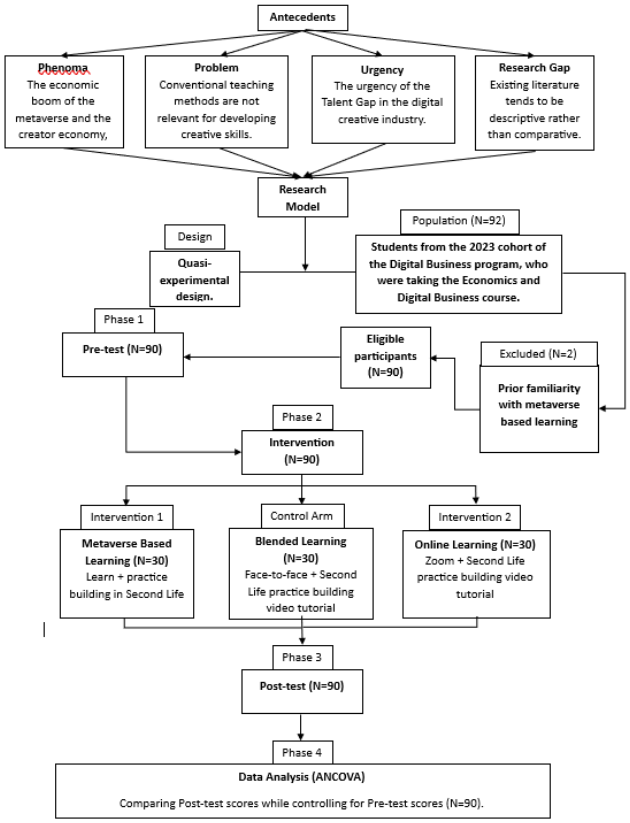

Figure 1. ARM framework for the research procedure

The research instrument was designed to measure the students' level of cognitive understanding, which was divided into two primary areas: Digital Business Competence and Creative Skills. Both areas are considered essential for success within the metaverse economy. Digital Business Competence was assessed based on the students' understanding of the fundamental concepts and history of the metaverse, business strategies in virtual markets, and the creator economy. On the other hand, Creative Skills were assessed based on more practical understanding, such as the concept and use of basic objects, tool navigation abilities, and the functions and workflow for creating within the virtual platform.

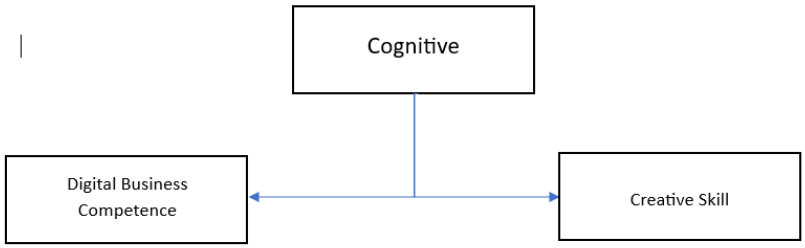

Figure 2. Instrument

The research instrument in this study was self-developed based on an in-depth Focus Group Discussion (FGD) with three domain experts who possess substantial experience in the field of metaverse-based education and digital business. Two of these experts are practitioners actively engaged in the economic and business ecosystem of the metaverse platform, while one expert is a learning specialist from Medusa Technology, focusing on pedagogical design and learning experience within metaverse environments. Content validity was ensured through expert judgment (Creswell & Creswell, 2018). Item validity was tested using the r-table value based on standard quantitative research methods (Sugiyono, 2018). Reliability was tested using Cronbach's Alpha coefficient, wherein a value above 0.70 is considered to indicate good reliability (Tavakol & Dennick, 2011; Field, 2013).

1. Content Validity: To ensure the relevance and representation of the test items in relation to the domain being measured, content validation was performed by two experts. The validators consisted of one business practitioner from a metaverse platform and one academic in the field of digital economy and business. This procedure is essential to guarantee that the instrument comprehensively covers the material it is intended to measure (Creswell & Creswell, 2018). The quantitative assessment results showed that all 25 items received an average score of 4.0 (highly relevant) from both experts, indicating that the instrument possesses very high content validity.
2. Construct Validity and Reliability: After content validity was established, the instrument was pilot-tested with 90 respondents for statistical analysis.

   - Item Validity Test: An item-total correlation analysis was conducted to test the discriminatory power of each item. This procedure is important to ensure that each item significantly contributes to the measurement of the same construct. An item is considered valid if its correlation coefficient value (r-computed) exceeds the critical value (r-table), which signifies a statistically significant correlation. With a sample size (N) of 90 and a significance level (α) of 5%, the r-table value used was 0.207 (Sugiyono, 2018).

   - Reliability Test: An internal consistency test was conducted on the 20 items that were proven to be valid. Cronbach's Alpha coefficient was used due to its broad capability to evaluate the extent to which a set of items consistently measures the same latent construct (Tavakol & Dennick, 2011). The analysis yielded a Cronbach's Alpha value of

0.796. This value is above the widely accepted threshold of $\alpha > 0.70$, which indicates that the final instrument has a good level of reliability and internal consistency for use in the research (Field, 2013).

C. RESULT AND DISCUSSION

RESULTS

Descriptive Analysist By N-Gain and Mean

Descriptive statistical analysis revealed variations in the initial abilities among the groups. In the pre-test, the highest mean score was achieved by the Metaverse Based Learning group (M = 79.00), followed by the Online Learning group (M = 77.00), and the Blended Learning group (M = 72.00). After the treatment, all groups showed significant improvement, with the highest raw post-test score being achieved by the Metaverse Based Learning group (M = 99.70).

To assess the effectiveness of the improvement more equitably, a Normalized Gain (N-Gain) analysis was conducted, a method widely used in educational research to measure the increase in conceptual understanding (Herayanti et al., 2022). The results indicated that the Blended Learning group achieved the highest N-Gain score (0.94), followed by the Online Learning group (0.93), and the Metaverse Based Learning group (0.89). According to the Hake (1999) standard, all three methods demonstrated effectiveness in the "High" category.

Table 4. Descriptive Statistics of Pre-Test and Post-Test Scores

Model	N	Pre-Test (Mean and STDEV)	Post-Test (Mean and STDEV)	N-Gain	Categories
Metaverse Based Learning	30	79.00 and 17.22	99.70 and 1.27	0.89	High
Online Learning	30	77.00 and 19.44	98.80 and 2.21	0.93	High
Blended Learning	30	72.00 and 16.98	99.00 and 2.07	0.94	High

A subsequent analysis was focused on the 7 post-test items that specifically measure practical (building) skills. The results present a particularly insightful, albeit counter-intuitive, finding. The Blended Learning group demonstrated the most significant quantitative improvement, achieving the highest post-test score (97.14) and N-Gain score (0.94).

Table 5. Descriptive Statistics of Pre-Test and Post-Test Scores for the 7 Items

Model	N	Pre-Test (Mean and STDEV)	Post-Test (Mean and STDEV)	N-Gain	Categories
Metaverse Based Learning	30	71.44 and 22.84	92.38 and 12.55	0.85	High

Online Learning	30	72.86 and 23.63	92.86 and 14.36	0.89	High
Blended Learning	30	68.36 and 23.31	97.14 and 6.31	0.94	High

ANCOVA Analysist

An Analysis of Covariance (ANCOVA) was used to test the main research hypothesis. This statistical method is specifically designed to control for baseline differences (the pre-test score) when comparing group means in experimental and quasi-experimental research (Khammar et al., 2020). The results indicated that the hypothesis was rejected. Although the initial scores (pre-test) were found to have a significant effect on the final scores (F(1,86) = 5.077, p = .027), no statistically significant difference in effectiveness was found among the three learning models (F(2,86) = 0.989, p = .376$). A very small Partial Eta Squared value also confirmed that the learning model factor accounted for only 2.2% of the variance in the final scores, a methodological result similarly reported in other quasi-experimental educational comparisons (Talan & Gulsecen, 2019).

Table 6. Analysis of Covariance (ANCOVA) Results

Varians	Df	Mean Square	F	Sig. (p)	Partial Eta Squared
Skor_Pretest	1	1555.958	5.077	0.027	0.056
Kelompok	2	303.146	0.989	0.376	0.022

When controlling for the influence of prior knowledge, the adjusted post-test scores reveal a subtle, non-significant trend, with the Metaverse Based Learning group showing the highest adjusted mean (M = 77.53), closely followed by the Online Learning group (M = 77.26).

Table 7. Adjusted Mean Post-Test Scores

Model	Mean	Std. Error
Metaverse Based Learning	77.530	3.236
Online Learning	77.258	3.214
Blended Learning	71.879	3.201

Qualitative Findings

Qualitative data collected concurrently, following a mixed-methods approach (Schoonenboom & Johnson, 2017), revealed findings that contrast with the quantitative results.

1. Observation: Student engagement patterns (Table 8) showed that the Metaverse Based Learning group had a "Very High" level of interaction, while the Online and Blended groups were "Low" and "Lowest", respectively.
2. Interviews: Thematic analysis of Metaverse Based Learning student interviews (Kiger & Varpio, 2020) yielded two primary positive themes: (1) "emotional

3. engagement & motivation" and (2) "enhanced conceptual understanding through direct practice." One critical constraint was also identified: (3) "infrastructure and technical burdens."
4. Task Analysis: Analysis of the building task results (Figure 3) showed that Metaverse Based Learning students frequently engaged in spontaneous creativity, personalizing their work with unique elements not required by the assignment, a behavior not observed in other groups.

Table 8. Student Engagement Patterns Based on Observation

Model	Level of Interaction & Questions
Metaverse Based Learning	Very High (Majority of Students)
Online Learning	Low (4-5 Students)
Blended Learning	Lowest (2 Students)

Figure 3. Building Task Completion Results in Metaverse Based Learning

DISCUSSION

The primary objective of this study was to evaluate the effectiveness of three distinct learning models. The main quantitative analysis led to the rejection of the research hypothesis, as the ANCOVA test found no statistically significant difference in effectiveness among the three groups ($F(2,86) = 0.989$, $p = .376$). This statistical equivalence, supported by N-Gain scores uniformly in the "High" category, indicates that for the acquisition of foundational cognitive knowledge, all three methods are equally effective. However, this statistical parity masks a fundamental divergence in the quality and nature of the learning process revealed through the qualitative findings; this discrepancy highlights the value of a mixed-methods approach, where qualitative data provides a deeper, contextualized understanding that quantitative results alone cannot capture (McLeod, 2024). Observations consistently showed that the Metaverse Based Learning group demonstrated a far superior level of practical interaction, engagement, and motivation. This creates a central paradox: why did the pedagogically superior model fail to produce statistically superior results?

The answer likely lies in the counter-intuitive finding regarding practical skills and the robust explanatory power of Cognitive Load Theory (Sweller, 1994; Sweller et al., 2019). The data revealed that for specific technical skills (the 7 building items), the Blended Learning group performed best. This suggests that the "brute-force" full

immersion of the MBL group was less effective. Students in the Metaverse Based Learning group faced a dual cognitive burden: they had to simultaneously process the intrinsic load (how to build) and a high extraneous load (navigating a novel 3D interface and dealing with technical frustrations). This aligns with systematic reviews which confirm that while immersive technologies can enhance learning, they also risk imposing a high extraneous cognitive load if the interface is complex or unfamiliar (Poupard et al., 2025). This cognitive overload may have hindered their ability to encode skills, potentially leading to what Kapur (2016) terms "unproductive failure." This finding provides empirical weight to the concerns raised by Yudhanto et al. (2023) regarding the readiness of Indonesian higher education, as the high extraneous load observed is a direct manifestation of the infrastructural and digital literacy gaps they identified. Conversely, the Blended Learning model effectively managed this cognitive load by providing a scaffold, allowing students to automate foundational knowledge before entering the complex environment, thus facilitating a smoother transition to competence.

Despite these technical hurdles, the qualitative superiority of the Metaverse Based Learning group was undeniable, a phenomenon best explained by Situated Learning Theory (Lave & Wenger, 1991). Unlike the other models, the metaverse provided an authentic "community of practice." Students were not passive recipients but active participants who co-constructed knowledge through social interaction. The two emergent themes from interviews "emotional engagement & motivation" and "enhanced conceptual understanding through direct practice" empirically support this. Scoping reviews on virtual reality confirm that this sense of immersion and agency significantly enhances student motivation, a key component of situated engagement (Jiang & Fryer, 2024). This also supports long-standing findings that these platforms leverage the unique affordances of 3D environments (Inman et al., 2010; Warburton, 2009; Dalgarno & Lee, 2010).

Arguably the most compelling evidence of the Metaverse Based Learning model's unique value was a phenomenon observed exclusively within this group: spontaneous creativity. Students independently transcended the task requirements to personalize their work and create original designs. This is a direct manifestation of achieving the highest level of cognitive competence in Bloom's Revised Taxonomy: "Creating" (Krathwohl, 2002). This aligns with research showing that practical, project-based learning models (similar to the Metaverse Based Learning task) have a significant impact on developing students' creative thinking skills (Fadhil et al., 2021). This critical learning outcome was not captured by the cognitive test instrument. This finding powerfully explains the discrepancy between the equivalent quantitative scores and the superior qualitative experience. Furthermore, it serves as an empirical demonstration of theories by Catalano (2015) and Zheng (2010), which argue that situated learning is superior for facilitating the transfer of knowledge to authentic application.

Ultimately, this study concludes that the absence of a statistical difference does not imply identical pedagogical quality. The lack of statistical significance is likely

explained by two key factors: (1) the high extraneous cognitive load from technical and digital literacy barriers, which suppressed the Metaverse Based Learning group's true potential, and (2) a "ceiling effect" in the research instrument, which failed to measure the most vital, higher-order creative outcomes. While all three methods are effective for mastering foundational knowledge, Metaverse Based Learning offers a uniquely potent environment for fostering authentic engagement and motivation. This finding resonates with research highlighting that digital literacy (a key barrier identified in this study's Metaverse Based Learning group) is a critical component in strengthening the character and motivation required to succeed in the new Society 5.0 era (Yuniarto & Yudha, 2021). This suggests Metaverse Based Learning excels in fostering the innovative skills required for the modern creator economy.

D. CONCLUSION

The data analysis in this study reveals an interesting duality of results. Quantitatively, no significant difference was found in the improvement of cognitive scores among the learning models, with all three methods proving to be equally effective in the "High" category. However, behind this equivalence in scores, the qualitative findings consistently show that the Metaverse Based Learning model was fundamentally superior. It succeeded in creating a unique learning experience by fostering a very high level of interaction, active participation, and stimulating spontaneous creativity not observed in the other groups. Thus, it can be concluded that if the objective is the mastery of standard knowledge, all three methods are equally effective. However, if the goal is to develop active and creative learners, Metaverse Based Learning shows the most superior potential.

Nevertheless, the findings regarding the qualitative superiority of Metaverse Based Learning must be interpreted while considering several limitations. First, there is the possibility of a *ceiling effect* in the test instrument, where less difficult questions may have masked the true differences in effectiveness. Second, the performance of the Metaverse Based Learning group was likely not optimal due to technical constraints such as connectivity and device specifications, which were a source of frustration. Lastly, the high enthusiasm in the Metaverse Based Learning group could have been partly influenced by the *novelty effect*, where the appeal of a new technology might temporarily increase engagement in a way that may not be sustainable long-term.

In response to these findings and limitations, several future steps can be formulated. For future research, it is recommended to use instruments with a higher level of difficulty to capture broader learning dimensions. Furthermore, a longitudinal study is essential to test whether the advantages of Metaverse Based Learning in terms of engagement can be sustained after the novelty effect fades. Practically, the implication is that educators can choose a learning method according to specific goals, where Metaverse Based Learning can be a very powerful tool for enhancing participation and creativity. However, the main prerequisite is that educational institutions must ensure

comprehensive infrastructure readiness before adoption, in order to guarantee a smooth and effective learning experience for all students.

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