The Development of Virtual Classrooms (Metaverse) to Promote Reading

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Abstract

Research on how immersive virtual environments like the metaverse can be effectively implemented to improve learning outcomes has been burgeoning recently. However, there remains a significant gap in understanding how virtual classroom environments might leverage students' affinity for digital technology to foster increased reading engagement and achievement. To fill this research gap, this study aimed to develop a virtual classroom (Metaverse) to promote reading, compare students' learning achievement before and after using the virtual classroom, and study their satisfaction with this approach. The sample consisted of 30 students from Grade 8/3 at Nong Ngu Lueam Phitthayakhom School, under the Nakhon Ratchasima Provincial Administrative Organization, during the academic year 2023, selected using cluster random sampling. Research instruments included a Metaverse based lesson plan for reading promotion, a learning achievement test, and a satisfaction questionnaire, with data analyzed using descriptive statistics and t-test analysis. The findings indicated that the overall appropriateness of the virtual classroom (Metaverse) for promoting

reading was rated at the highest level. Learning achievement improved significantly, with average scores increasing from 13.80 (46.00%) in the pre-test to 22.23 (74.10%) in the post-test, a 28.10% improvement that was statistically significant at the .05 level. Student satisfaction with the virtual learning environment was also exceptionally high. This research contributes to educational technology by demonstrating how virtual environments enhance reading skills among middle school students. It provides insights for engaging digital-native learners and addressing declining reading habits. By establishing evidence for Metaverse applications in education, this study supports future implementation across diverse contexts, potentially transforming teaching methodologies in the digital learning landscape.

Keywords: virtual classroom, reading promotion activities, learning achievement

Introduction

Reading significantly influences personal development by fostering intellectual and emotional growth, enhancing communication skills, and promoting critical thinking. Research indicates that reading habits among students substantially affect their academic performance and personal development, with a majority acknowledging its importance for educational success (Appalabatla & Priya, 2023; Belo et al., 2024). Reading not only expands vocabulary and comprehension but also cultivates creativity and empathy, essential attributes in today's interconnected world (Belo et al., 2024). The increasing preference for digital materials among students reflects the evolving nature of reading habits, suggesting a transition toward more accessible formats (Adhikari, 2023). In contemporary technological contexts,

maintaining reading habits remains essential for developing critical thinking and information processing skills vital in both academic and professional environments (Dukare, 2023). Educators play a pivotal role in motivating students to engage with diverse texts, thereby enriching their reading experiences and fostering lifelong habits that contribute to improved mental well-being and resilience (Sear, 2024; Belo et al., 2024). These findings collectively underscore the importance of cultivating reading habits across all demographic groups to foster a well-educated society.

From the study of the current situation, the issue of diminishing reading interest among Thai citizens is multifaceted, influenced by educational, social, and economic factors. Key challenges include insufficient institutional support, teachers' perceptions regarding reading instruction, and students' motivation and reading habits, which impede the effective implementation of extensive reading programs (Thongsan & Waring, 2024). The proliferation of digital media and electronic devices has diverted attention from traditional reading practices, complicating efforts to foster a reading culture (Zalukhu & Zalukhu, 2024). Reader characteristics, including age and educational attainment, significantly influence intentions to engage with electronic books, indicating that targeted strategies are necessary to enhance digital literacy and promote reading in this context (Sinchawarnwat & Pankham, 2024). Limited access to quality reading materials and supportive learning environments further exacerbates this problem, necessitating collaborative initiatives among educational institutions, families, and communities to cultivate positive literacy practices (Seventilova, 2024; Ermiana et al., 2024).

Modern educational technology improves accessibility, engagement, and instructional efficacy, all of which are critical components of better teaching management in educational institutions. Within educational institutions, the incorporation of digital tools, including school management information systems and e-learning platforms, promotes better communication, administration, and decision-making (Fadillah et al., 2024; Manaf, 2024). The educational environment is enhanced by the immersive learning experiences that contemporary educational technologies, such as virtual and augmented reality, provide, accommodating a variety of learning styles (Junger et al., 2023; Mubaroq & Ilham, 2023). Furthermore, to create productive learning environments and enhance educational outcomes, a well-rounded strategy that combines cutting-edge technology with conventional pedagogical approaches is necessary (Junger et al., 2023; Manaf, 2024).

From the study of the current reading promotion activities, it was found that modern technology has been applied as a tool to promote reading and develop skills in the 21st century by applying the Metaverse, a digital technology that combines AR and VR technologies. This new technology can attract learners by allowing them to create virtual representations of themselves, called avatars. The metaverse provides a virtual world that is freely accessible and offers activities that learners want to engage with, enabling them to interact with each other as if they were in the real world. Participants need not be in the same physical location; regardless of where they are, everyone can join without borders (Charuphan, 2021). The concept of virtual classrooms within the metaverse leverages advanced technologies such as virtual reality (VR), augmented reality (AR),

and artificial intelligence (AI) to create immersive educational experiences. Research demonstrates that these environments enhance student engagement and collaboration by providing personalized learning experiences that simulate authentic interactions (AL Seiari et al., 2023; Hedrick et al., 2022). The integration of AI-driven virtual avatar assistants facilitates dynamic interactions, enabling students to engage more effectively with instructional content and peers (Halim et al., 2024).

The integration of metaverse technologies into virtual classrooms represents a transformative approach to promoting reading engagement, leveraging immersive environments to enhance comprehension and motivation. Research shows that metaverse platforms allow teachers to use new teaching methods, bringing reading materials to life with virtual characters and interactive features, which helps students think and feel more deeply about what they read (Rezk, 2024). Metaverse libraries enhance access to diverse reading materials and facilitate collaborative learning experiences, transcending geographical constraints and enabling substantive peer discussions (Namdas, 2024). The immersive characteristics of metaverse environments support scenario-based learning, simulating authentic contexts for reading comprehension and promoting deeper understanding and retention (He et al., 2022). Furthermore, the capacity for personalized learning trajectories can accommodate individual reading preferences, enhancing motivation and engagement in literacy activities (Yue, 2023).

Despite metaverse technologies' educational promise globally, significant research gaps exist regarding their application to Thailand's declining reading engagement. While studies have examined the metaverse in education (AL Seiari et al., 2023; Hedrick et al., 2022) and virtual

environments for literacy development (Rezk, 2024; Namdas, 2024), limited research explores how metaverse environments can be culturally adapted for Thai readers. Current literature inadequately addresses how immersive technologies can overcome cultural, linguistic, and motivational barriers specific to Thai educational contexts (Thongsan & Waring, 2024). Although technical implementation aspects have been studied, pedagogical frameworks for using metaverse technologies to cultivate sustainable reading habits among Thai students remain absent. This gap is particularly important given Thailand's declining reading rates and the need for innovative approaches that engage digital-native learners while preserving cultural literacy values.

This research aims to develop and evaluate a culturally responsive metaverse-based learning environment specifically designed to enhance reading engagement and comprehension among Thai students, thereby addressing the critical gap in immersive technology applications within Thai reading education contexts and contributing to the reversal of declining reading habits in Thailand's increasingly digitalized society.

Research Objectives

1. To develop lesson plans by using the virtual classroom (Metaverse) to promote reading.

2. To compare students' learning achievement before and after learning by using a virtual classroom (Metaverse) to promote reading.

3. To study students' satisfaction with the usability of the virtual classroom (Metaverse) to promote reading.

Research Scope

This research focuses on the develops a virtual classroom (metaverse) to promote reading among lower secondary students, focusing primarily on investigating pedagogical approaches for junior secondary reading skills development. The study began with a comprehensive literature review of both Thai and international sources on reading instruction and virtual learning environments, which informed the design of an immersive, interactive digital classroom. The virtual classroom underwent expert validation by specialists in library science, curriculum and instruction, and educational technology before being piloted in an actual classroom setting. The research sampled 30 eighth-grade students from Nong Ngu Lueam Phitthayakhom School in Nakhon Ratchasima Province, selected through cluster random sampling from a population of 242 lower secondary students. Instructional content was adapted from royal literary works by Her Royal Highness Princess Maha Chakri Sirindhorn, integrated into contextually appropriate learning activities within the digital environment. The research and development process spanned five months, from November 2023 to March 2024.

Based on a review of relevant concepts, theories, and empirical research, the researcher established a conceptual framework to guide the design of a Metaverse-based virtual classroom aimed at promoting reading. The framework integrates the following three key theoretical perspectives:

1. Metaverse in Education

The metaverse combines augmented reality (AR) and virtual reality (VR) to create immersive learning environments where learners

interact through avatars in interconnected digital spaces (Charuphan, 2021; Seesamut, 2022). These environments support 21st-century skills development within continuous and interoperable virtual worlds that enable spontaneous interaction (Park & Kim, 2022; Mystakidis, 2022).

2. Self-Directed Learning Theory

Self-directed learning emphasizes learner autonomy through goal-setting and self-assessment. Key elements include intrinsic motivation, metacognition, and the ability to plan and monitor learning progress (Gary, 2022; Peno, 2024). Instructional models like flipped classrooms support SDL by encouraging independence and collaboration, essential for effective use of educational technologies (Anshu et al., 2022).

3. Constructivist Learning Theory

Constructivism posits that learners build knowledge through experiences, social engagement, and reflection. Vygotsky's zone of proximal development and Bruner's discovery learning highlight the importance of guided interaction and exploration (Tohari & Rahman, 2024). Constructivist pedagogy transforms teachers into facilitators within student-centered environments (Kusuma et al., 2021; Oanh & Nhung, 2022), while technologies like Learning Management Systems enhance learner engagement and personalization (Zin et al., 2024).

4. Reading Promotion Concepts

Effective reading promotion integrates traditional and modern strategies through digital media and targeted content (Ye, 2024). Creative management of events like book fairs stimulates reading motivation Filina & Kostelna, 2023). Schools can combine sustained silent reading with digital tools like storytelling apps to enhance interest in recreational reading (Tupas,

2023), while school libraries can leverage social media to connect with students (Petrushka & Mashtalir, 2023).

5. Virtual Reality in Reading Promotion

VR enhances reading engagement through immersion, improving comprehension and motivation. Applications like StoryVR increase narrative absorption (Kubincová et al., 2020), while high-immersion VR environments significantly improve reading comprehension compared to traditional formats (Kaplan-Rakowski & Gruber, 2024). VR enables higher cognitive engagement and memory retention, creating dynamic reading environments suitable for complex texts and language learners (Çoban et al, 2024).

6. Conceptual Framework for Metaverse Virtual Reading Classroom

The design of a Metaverse-based virtual classroom for reading promotion integrates theoretical foundations into seven key components and a structured self-directed learning process.

6.1 Components of the Virtual Reading Classroom

6.1.1 Virtual Library Space: Digital bookshelves organizing royal literary works by category, comfortable reading corners, and informational displays about the works and their significance.

6.1.2 Digital Content: Interactive eBooks of royal works, contextual supplementary information, and multimedia materials (photos, videos, audio) connected to the narratives.

6.1.3 Activity Spaces: Discussion zones for debates, exhibition areas for student projects, and gamification zones featuring quizzes and interactive puzzles.

6.1.4 Reading Tools: Digital notebooks for reflections, virtual maps for exploring travelogue routes, and mind mapping tools for synthesizing ideas.

6.1.5 Interaction System: Avatars representing teachers and students, chat systems, and voice channels for real-time communication.

6.1.6 Monitoring and Assessment Tools: Virtual quizzes for comprehension assessment, activity logs tracking participation, and satisfaction surveys.

6.1.7 Self-Directed Learning Support: User guides, learning plan templates, and structured reflection forms.

6.2 Self-Directed Learning Process The virtual classroom implements a six-phase learning process:

6.2.1 Orientation: Introduction to the SDL model, roles, tools, and expectations.

6.2.2 Planning: Students explore resources and create personalized learning goals and plans.

6.2.3 Implementation: Learners engage in activities with teacher guidance and progress tracking.

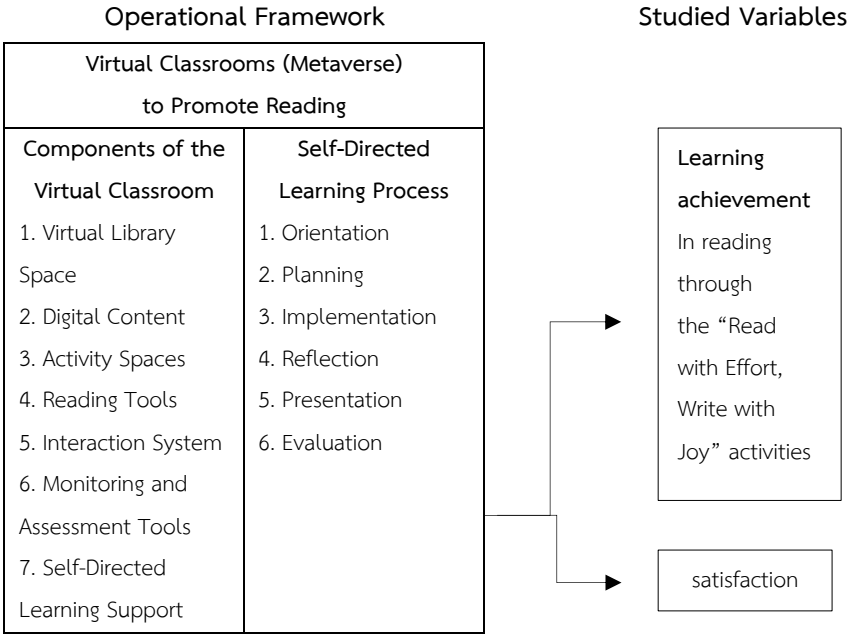
6.2.4 Reflection: Students assess their progress and adjust plans as needed.

6.2.5 Presentation: Learners share their work and insights, exchanging feedback with peers.

6.2.6 Evaluation: Multiple assessment methods including self-assessment, peer review, and teacher evaluation.

The researcher conducted an extensive review of relevant theories, principles, and conceptual frameworks through document analysis and prior

research. These findings were then analyzed, synthesized, and applied to develop a Metaverse-based virtual classroom aimed at promoting reading. The developed platform was subsequently used to investigate and compare students' learning achievement and satisfaction with the Metaverse learning environment, as illustrated in Figure 1.



Research Methodology

The development of a Metaverse-based virtual classroom to enhance reading skills consists of three key phases:

Phase 1: Development of lesson plans by using the virtual classroom (Metaverse) to promote reading.

Phase 2: Comparison of students' learning achievement before and after learning by using a virtual classroom (Metaverse) to promote reading.

Phase 3: Study of students' satisfaction with the usability of the virtual classroom (Metaverse) to promote reading.

Phase 1: Development of lesson plans by using the virtual classroom (Metaverse) to promote reading.

1. Data Sources

The data for this study were obtained from academic documents, theoretical principles, concepts, and prior research related to Metaverse-based virtual classrooms for reading enhancement conducted by both Thai and international scholars and educators.

2. Informants

The study engaged three experts: specialists in library science, curriculum and instruction, and educational technology.

3. Implementation Process

The development of the Metaverse-based virtual classroom for reading enhancement was conducted through the following steps:

3.1 Literature Review

A review of literature and research related to virtual classrooms (Metaverse), the use of the Spatial program and its application in teaching and learning, self-directed learning concepts, principles of reading promotion for lower secondary school students, and the types and content of literary works authored by Her Royal Highness Princess Maha Chakri Sirindhorn.

3.2 Lesson Plan Design.

The design of lesson plans by using the virtual classroom (Metaverse) to promote reading integrates theoretical foundations into seven key components and a structured self-directed learning process.

3.2.1 Components of the virtual reading classroom consist of virtual library space, digital content, activity spaces, reading tools, interaction systems, and monitoring and assessment tools.

3.2.2 Self-Directed Learning Process: The virtual classroom implements a six-phase learning process consisting of orientation, planning, implementation, reflection, presentation, and evaluation.

3.3 Expert Review

The developed lesson plans by using the virtual classroom (Metaverse) to promote reading was evaluated by three experts using an assessment questionnaire to determine its appropriateness and alignment with educational objectives. A rating scale was employed for the assessment (Tanya, 2002, pp. 161–162), with the following scoring criteria:

5 = Highly appropriate and consistent

4 = Appropriate and consistent

3 = Moderately appropriate and consistent

2 = Slightly appropriate and consistent

1 = Least appropriate and consistent

The evaluation followed a predetermined rating scale (Srisasaad, 2013, p. 103) as follows:

Mean score 4.51–5.00 = Highly appropriate and consistent

Mean score 3.51–4.50 = Appropriate and consistent

Mean score 2.51–3.50 = Moderately appropriate and consistent

Mean score 1.51–2.50 = Slightly appropriate and consistent

Mean score 1.00–1.50 = Least appropriate and consistent

The overall mean score from expert evaluation was 4.35 (S.D. = 0.48), which was higher than the established quality acceptance criteria (3.51).

3.4 Revision and Refinement

Based on the experts' feedback, modifications and improvements were made to the lesson plans by using the virtual classroom (Metaverse) to promote reading to enhance their effectiveness and ensure their alignment with the intended objectives.

4. Data Analysis

The collected data were analyzed using mean scores ($\bar{x}$) , standard deviation (S.D.) and content analysis.

Phase 2: Comparison of students' learning achievement before and after learning by using a virtual classroom (Metaverse) to promote reading.

1. Population and Sample

1.1 Population:

The population for this study consisted of 242 lower secondary school students at Nong Ngu Lueam Pittayakom School under the jurisdiction of the Nakhon Ratchasima Provincial Administrative Organization for the academic year 2023.

1.2 Sample:

The sample group comprised 30 students from Grade 8/3 at Nong Ngu Lueam Pittayakom School, selected for the academic year 2023. The sample was selected using cluster random sampling.

2. Research Instruments

The research instruments were divided into two categories: experimental tools and data collection tools.

2.1 Experimental Tool:

The lesson plans by using the virtual classroom (Metaverse) to promote reading.

2.2 Data Collection Tools:

The primary instrument for data collection was a learning achievement test consisting of 30 items that had undergone quality verification. The test had a difficulty index (p) ranging from 0.20 to 0.80, a discrimination power (r) of 0.20 or higher, and a reliability coefficient for the entire test of not less than 0.70.

3. Data Collection Procedures

3.1 Pre-Test:

Students' learning achievement was assessed before the intervention using a learning achievement test.

3.2 Instructional Implementation:

Students engaged in learning activities based on the instructional design using the Metaverse-based virtual classroom.

3.3 Post-Test:

A post-test was conducted to evaluate students' learning achievement following the intervention.

3.4 Data Analysis:

The results from the pre-test and post-test were analyzed to determine the effectiveness of the Metaverse-based virtual classroom in enhancing reading skills.

4. Data Analysis

The data were analyzed using percentage, mean scores, standard deviation, and the t-test.

Phase 3: Study of students' satisfaction with the usability of the virtual classroom (Metaverse) to promote reading.

1. Population and Sample

1.1 Population

The population of this study comprised 242 lower secondary school students at Nong Ngu Lueam Pittayakom School, under the jurisdiction of the Nakhon Ratchasima Provincial Administrative Organization, during the academic year 2023.

1.2 Sample

The sample group consisted of 30 students from Grade 8/3 at Nong Ngu Lueam Pittayakom School, selected for the academic year 2023. The sample was selected using cluster random sampling.

2. Research Instrument

The research instrument used in this phase was a student satisfaction questionnaire on the usability of the virtual classroom (Metaverse) to promote reading. The instrument featured a 5-point Likert scale addressing five dimensions: classroom design and usability, content presentation, reading activities, interaction, and learning benefits. A rating scale was employed for the assessment (Tanya, 2002, pp. 161–162), with the following scoring criteria:

5 = Very Highly Satisfied

4 = Highly Satisfied

3 = Moderately Satisfied

2 = Slightly Satisfied

1 = Least Satisfied

Content validity was established through expert review, selecting items with IOC values ≥0.50, and implementing recommended revisions.

3. Data Collection Procedures

3.1 Administration of the Satisfaction Questionnaire

Upon completion of the learning activities in the Metaverse-based virtual classroom, all students were required to complete the satisfaction questionnaire.

3.2 Data Compilation and Synthesis

The collected responses from the student satisfaction questionnaire were compiled, summarized, and synthesized for further analysis.

4. Data Analysis

The data were analyzed using percentage. The evaluation followed a predetermined rating scale (Srisasaad, 2013, p. 103) as follows:

Mean score 4.51–5.00 = Very Highly Satisfied

Mean score 3.51–4.50 = Highly Satisfied

Mean score 2.51–3.50 = Moderately Satisfied

Mean score 1.51–2.50 = Slightly Satisfied

Mean score 1.00–1.50 = Least Satisfied

Research Results

The development of a virtual classroom (Metaverse) to promote reading presents the study results in the following sequential stages:

Step 1: Development of lesson plans by using the virtual classroom (Metaverse) to promote reading.

The Virtual Classroom (Metaverse) to Promote Reading was designed based on a framework incorporating virtual library space, digital content, activity areas, reading promotion tools, interaction systems, and assessment tools. Using Spatial as the primary platform, the design features a virtual library showcasing royal-authored books, reading promotion areas, journey maps based on royal writings, and student exhibition spaces.

Content includes digitized books by Her Royal Highness Princess Maha Chakri Sirindhorn, historical context information, and multimedia elements. Reading promotion activities include virtual notebooks, travel maps, discussion forums, exhibitions, interactive games, and creative writing exercises. The learning management methodology follows a 6-step Self-Directed Learning Process framework: orientation, planning, implementation, reflection, presentation, and evaluation.

Consistency and Appropriateness of Lesson Plans by Using Virtual Classrooms (Metaverse) to Promote Reading. The overall consistency and appropriateness of lesson plans by using virtual classrooms (Metaverse) to promote reading had a mean value of 4.76 (S.D. 0.32), which is at the highest level. The aspect with the highest mean value was the components of lesson plans (mean = 4.85), followed by reading promotion activities (mean = 4.81), virtual classroom design (mean = 4.79), implementation (mean = 4.68), and measurement and evaluation (mean = 4.67), respectively.

Step 2: Comparison of students' learning achievement before and after learning by using a virtual classroom (Metaverse) to promote reading.

The study of student achievement found that before learning, students achieved an average score of 13.80 (S.D. = 3.42), equivalent to 46.00%. After learning, the average score was 22.23 (S.D. = 2.75), or 74.10%, with an average progress score of 6.66 (S.D. = 2.18), equivalent to 22.20%. The learning achievement after implementing the learning management was significantly higher than before implementation at the .05 statistical significance level.

Step 3: Study of students' satisfaction with the usability of the virtual classroom (Metaverse) to promote reading.

Overall student satisfaction was high (mean = 4.13, S.D. = 0.57). Highest satisfaction ratings were for enjoyment (mean = 5.00, S.D. = 0.00), activity creativity (mean = 4.84, S.D. = 0.37), and knowledge enhancement (mean = 4.83, S.D. = 0.38). Other well-received aspects included learning media (mean = 4.33), systematic planning (mean = 4.17), and creative development (mean = 4.00).

These results suggest that the Metaverse-based virtual classroom effectively enhanced students' reading skills, led to significant academic improvement, and was well-received by students, with high satisfaction levels across various aspects of the learning experience.

Discussion Of Results

The findings from this study on the development of a metaverse-based virtual classroom for reading enhancement can be discussed as follows:

1. The results of the development of lesson plans by using the virtual classroom (Metaverse) to promote reading

This study successfully developed and implemented a virtual classroom in the metaverse to promote reading, structured around a six-step self-directed learning process. The design included immersive components such as digital royal-authored books, interactive reading activities, and student exhibition areas. These findings align with prior research emphasizing the benefits of immersive learning environments in enhancing engagement and learner autonomy (Al Seiari et al., 2023). Similar research integrating immersive technologies in language learning has shown positive effects on reading habits and content retention (Kongchan, 2022).

The high consistency ratings of the lesson plans (mean = 4.76, S.D. = 0.32) confirm the methodological rigor of the instructional design. All aspects of the evaluation received scores in the highest category, with components of learning management plans scoring the highest (mean = 4.85, S.D. = 0.25). These findings echo Flores-Castañeda et al. (2024), who argue that well-structured virtual environments enhance learner engagement and instructional clarity.

2. Comparative results of students' learning achievement before and after learning by using a virtual classroom (Metaverse) to promote reading

The significant improvement in student achievement provides strong evidence for the effectiveness of the metaverse classroom in promoting reading skills. Pre-test scores averaged 13.80 (S.D. = 3.42, 46.00%), while post-test scores rose to 22.23 (S.D. = 2.75, 74.10%), representing a statistically significant increase of 28.10% ($t = 15.47$, $df = 29$, $p < .001$). These

results demonstrate that the immersive virtual environment positively impacts learning outcomes, consistent with López Belmonte et al. (2024), who found that metaverse technologies provide equitable access to high-quality content regardless of geographic location.

The primary beneficiaries of this research are secondary students, who demonstrated significant academic improvement as noted above. The results indicate potential for enhancing learning experiences across digital divides, particularly for students in rural or under-resourced regions where access to diverse reading materials may be limited.

3. Results of a study of students' satisfaction with the usability of the virtual classroom (Metaverse) to promote reading

Student satisfaction with the virtual classroom was high overall (mean = 4.13, S.D. = 0.57), with particularly strong ratings for enjoyment and entertainment (mean = 5.00, S.D. = 0.00), creativity of activities (mean = 4.84, S.D. = 0.37), and enhancement of knowledge and understanding (mean = 4.83, S.D. = 0.38). These findings suggest that the metaverse environment successfully combines educational value with engaging experiences, supporting research by Aditya et al. (2023) showing that metaverse-based tools help develop soft skills and flexible learning approaches.

There were some limitations reflected in the lower satisfaction scores for application to daily life (mean = 3.67, S.D. = 0.82) and cultivation of reading habits (mean = 3.33, S.D. = 0.92). Additionally, there was a learning curve associated with navigating the virtual platform, which initially hindered student engagement. Although these issues diminished over time, they underscore the importance of providing digital literacy support prior to Metaverse integration.

Teachers also benefit through exposure to modern pedagogical tools that stimulate creativity and learner interaction. The structured implementation framework provides educators with a replicable model for technology integration. Research has similarly shown that Metaverse-based tools help teachers develop soft skills and pedagogical flexibility (Aditya et al., 2023).

Despite overall positive outcomes, the implementation revealed barriers typical of EdTech interventions—limited broadband coverage, underpowered devices, and minimal IT support. These findings support Aditya et al. (2023), who stressed the importance of designing metaverse applications with context-specific constraints in mind.

Recommendations

1. Future development of Metaverse-based virtual classrooms for reading enhancement should incorporate a more diverse range of content. Expanding the scope of learning materials would provide greater variety in reading promotion activities, thereby enriching the overall learning experience.

2. This study primarily focused on the development of a Metaverse-based virtual classroom for reading enhancement. However, for long-term retention of knowledge and sustainable skill development, extended exposure and practice are essential. Therefore, it is recommended that learners be encouraged to engage in self-directed learning to further strengthen their reading habits and comprehension skills over time.

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