Online-Journals.org

iJIM International Journal of Interactive Mobile Technologies

iJIM | eISSN: 1865-7923 | Vol. 17 No. 21 (2023) | OPEN ACCESS

https://doi.org/10.3991/ijim.v17i21.41933

PAPER

Promoting Virtual Learning Management Competencies in the Metaverse with Mobile Technology to Support Competency-Based Learning for Computer Major Preservice Teachers

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ABSTRACT

The metaverse, a fundamental framework with the potential to revolutionize social communication and learning processes, offers an enhanced learner experience for accessing the real world. Proficiently developing virtual classrooms and effectively managing learning with current technology are essential skills for teachers. This study aimed to develop competency-based learning activities (CBLA) designed to enhance virtual learning management competencies among computer teacher students in the metaverse, using mobile technology to support. The research employed purposive sampling, selecting 78 students for participation. Data analysis involved statistical measures such as the mean, standard deviation, and one-group pre-test-post-test analysis of variance (ANOVA). The findings revealed that the CBLAs developed to enhance virtual learning management competencies in the metaverse consisted of eight components and four steps. Following the completion of the learning activities, students demonstrated a significant increase in their competencies in virtual learning management, surpassing 70% of the established criteria. The statistical analysis confirmed the significance of this improvement, with a p-value of less than 0.05. This study's results highlight the effectiveness of the developed CBLAs in enhancing virtual learning management skills among computer teacher students in the metaverse. The findings indicate that students experienced a significant improvement in their competencies after participating in the learning activities. Furthermore, the students expressed the highest levels of satisfaction conducted activities.

KEYWORDS

competency-based learning activities (CBLA), metaverse, mobile technology, virtual learning management

Sinlapaninman, U., Yonwilad, W., Pattanachai, N. (2023). Promoting Virtual Learning Management Competencies in the Metaverse with Mobile Technology to Support Competency-Based Learning for Computer Major Preservice Teachers. *International Journal of Interactive Mobile Technologies (iJIM)*, 17(21), pp. 97–114. https://doi.org/10.3991/ijim.v17i21.41933

Article submitted 2023-06-02. Revision uploaded 2023-09-08. Final acceptance 2023-09-08.

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1 INTRODUCTION

In the rapidly evolving landscape of education, the integration of technology has ushered in a new era of possibilities. As traditional classrooms expand into virtual realms, the idea of establishing classrooms within the metaverse and transforming online education has captured the imagination of both educators and learners. This transformative shift presents an unprecedented opportunity to not only enhance confidence and competencies in learning management but also to reshape the very foundations of teaching and learning. In this ever-changing environment, teachers and educational institutions find themselves at a critical juncture where traditional teaching methods converge with the limitless possibilities of the digital era. Aspiring educators are no longer just conduits of information; they are the architects of immersive learning experiences that go beyond the limitations of physical spaces. Before embarking on their teaching careers, these aspiring educators are undergoing a paradigm shift in their preparation. The modern educator is no longer confined to the four walls of a classroom. They are now required to be proficient in the art of teaching through digital mediums. The transformative journey towards becoming a computer teacher begins with comprehensive preparation encompassing technological prowess and innovative pedagogy. The rapidly evolving landscape of learning management demands that educators equip themselves with the necessary technological capabilities to navigate this ever-changing terrain. As the traditional boundaries of education dissolve in the wake of digital integration, there is an increasing demand for educators who are not only knowledgeable in their subjects but also skilled in utilizing technology [1, 2].

At the heart of this revolution lies the concept of fostering virtual learning management competencies through competency-based learning, an approach that strongly resonates with aspiring computer instructors. Unlike conventional methods that revolve around completing a predetermined curriculum, competency-based learning prioritizes the acquisition of specific skills and competencies. This shift aligns seamlessly with the ethos of the metaverse, a captivating virtual environment that invites educators to engage learners through immersive and interactive experiences [3]. Within this digital realm, students are no longer passive recipients of knowledge; they are active participants in their own educational journey. The metaverse, with its malleable and dynamic learning environment, serves as an ideal canvas for the application of competency-based learning [4, 5]. Empowered by the flexibility of the metaverse, students can set their own pace and design a personalized learning path [6]. They are no longer bound by the constraints of time and space, which enables them to delve deeper into subjects and develop crucial skills through experiential learning [7].

In this context, the underlying motivation of this research is abundantly clear: to bridge the gap between the virtual realm and the acquisition of competencies in learning management. Specifically targeting preservice teachers majoring in computer science, the goal is to utilize the power of the metaverse and competency-based learning to guide them in becoming proficient virtual educators. The paper's main objective is to emphasize the importance of providing future educators with the necessary skills and knowledge to effectively navigate the complexities of virtual learning management. By doing so, this endeavor not only empowers individual educators but also significantly contributes to the broader advancement of virtual education within the metaverse.

In conclusion, the convergence of education and technology has ushered in an era where classrooms transcend physical boundaries and learning embraces the

virtual expanse. The potential for developing virtual learning management skills through competency-based learning within the metaverse is highly promising for the field of education. As educators and learners embark on this transformative journey, the evolution of education unfolds, opening up possibilities for a future where pedagogy knows no limits.

2 LITERATURE REVIEW AND RELATED WORKS

2.1 Competency-based learning

Education in the twenty-first century is a period of rapid change in the world [8]. In order to cope with the volatile global trends of the VUCA (volatile, uncertain, complex, and ambiguous) world, education has become a crucial foundation for developing learners' abilities and competencies that can adapt to a rapidly changing global society, both in the present and the future. Therefore, the management of competency-based learning is a key aspect of learners' development [9]. This is in line with the concept that "competence is a better measure of job success than intelligence" [10]. Competency-based education, also known as competency-based learning, is a student-centered learning approach that assesses the learner's progress based on their abilities. There are studies that explore job competencies and inherent attributes that contribute to effective performance while also examining personal learning and competence. This approach includes various components to enhance performance, such as job analysis, general knowledge, specialized competency training, media, technology, and performance evaluation [5, 9, 11–14].

Therefore, teachers must possess the knowledge and skills to create a conducive learning environment that enables learners to achieve the desired performance. This can be achieved through an instructional approach that encourages schools and students to strive for mastery rather than mere memorization. It may involve a combination of internships, experiential learning, dual enrollment, vocational, and technical education programs. These approaches are often referred to as standards-based learning outcomes and work-based learning [15, 16]. This includes instructional models and assessment activities that aim to assess learners' mastery of learning by demonstrating the knowledge, attitudes, values, abilities, and behaviors required for the desired level [17]. However, before actually practicing teaching, which often requires knowledge and skills from multiple disciplines as well as knowledge sharing during the teaching process, prospective teachers can use classroom simulations to practice teaching and develop expertise in teaching and learning management [18, 19]. Classroom simulations are employed by educational institutes that train teachers to bridge the gap between theory and practice while also providing student instructors with a more controlled and safer environment compared to a live classroom. Students and instructors collaborate to address specific errors in the lesson, aiming to enhance accuracy and provide opportunities for students to share their learning outputs. As a result, student-teachers are better equipped to educate students using competency-based learning [20, 21].

2.2 Virtual learning on the metaverse

The metaverse is a platform that combines augmented reality (AR) and virtual reality (VR), and it is transforming the way we communicate and learn. It allows students

to experience interactive visualizations, information visualization applications, and imaginary scenarios in virtual worlds that they may never encounter or experience in the real world [22–28]. Participants in the metaverse create their own avatars, or "personalities," and engage with the environment, immersing themselves in dimensional visuals and experiencing various settings. Within this virtual society, identities and lives intertwine as abstract, physical, and complex events are transformed into touchable and palpable virtual representations. Simulations of the virtual world provide opportunities for students to practice fundamental skills until they reach proficiency [28]. Metaverse applications, driven by technological advancements and innovations, have the potential to facilitate the creation of engaging and fully immersive educational environments for learners. They have a significant impact on teaching and learning management within educational institutions, necessitating the adaptation of learning activities to ensure that student-teachers are proficient in managing virtual learning [24, 28–30]. This involves understanding the technical characteristics of each metaverse and subsequently designing lessons that enable students to engage in problem-solving and complete assignments [29].

The virtual classroom will be designed with the following features: Learning is supposed to be enjoyable and stress-free for students. In a multimedia classroom, students will study using visuals and sounds while also having control over the learning process at their fingertips. Asynchronous learning is a learning design in which the teacher and the learner are not required to be present at the same time and place. Teachers create lessons that students can study at their own convenience, regardless of location or time. In an electronic library, students will be able to get what they want by utilizing a search engine, including the environment and atmosphere of a classroom [30–32]. This provides the learner with the visual autonomy necessary to navigate the physical learning environment based on the learning arrangement using a mobile device [33]. This will enhance the success and effectiveness of learning in various situations. Using the metaverse in learning enhances the learning outcomes for enthusiastic learners who can quickly grasp and explore new concepts [4, 34]. Teachers and students, on the other hand, must understand and know how to defend themselves against cyber and social risks. The metaverse is also vulnerable to numerous privacy flaws caused by data obtained through VR technology. This exposes hackers and identity theft criminals to a range of deep learning techniques. These are the perils of the metaverse [10, 35].

2.3 Learning management competencies

Learning management competencies refer to the skills, knowledge, and capabilities essential for effectively overseeing the learning and development processes within corporate or educational settings. These proficiencies encompass the utilization of various strategies and protocols aimed at assisting learners in acquiring and retaining knowledge and skills [36]. As a consequence, humanity has harnessed technology to its advantage, focusing on developing tools that are specifically designed to achieve certain objectives. Technology has emerged as an active participant in various domains, such as medicine, education, and industry, driving the progression of human advancement. Consequently, technology plays a crucial role in facilitating human interaction and environmental communication in the lives of many people. Thus, it can be argued that technology has undergone evolution in terms of its content creation and development aspects [37–39].

Key skills in learning management include curriculum development, which involves planning and organizing the overall learning program; assessment and evaluation, which involves measuring learning outcomes and providing feedback; and learning technology, which involves utilizing digital tools and platforms for effective and engaging learning experiences [40]. Instructional design also involves creating effective learning materials and activities [41]. As learning managers frequently collaborate with stakeholders, instructors, and students to ensure the successful implementation of learning initiatives, their capabilities also encompass leadership and communication skills. They should be able to identify students' learning needs, create effective interventions, and adapt to changing educational trends and technological advancements [6].

Learning managers can effectively facilitate learning experiences, promote learner engagement, and contribute to the overall success of learning and development efforts within their organization or educational institution by developing and utilizing these competencies [2, 36].

This literature review emphasizes the importance of promoting virtual learning management competencies among preservice teachers majoring in computer science through competency-based learning in the metaverse. The metaverse offers an immersive and interactive environment that aligns well with competency-based approaches, enabling personalized and engaging learning experiences. Future research should focus on addressing the challenges associated with implementing virtual education and further exploring the impact of learning in the metaverse on student outcomes. By equipping educators with the necessary skills and knowledge, virtual education can be effectively promoted in the metaverse, resulting in improved learning experiences for students.

2.4 Preservice teacher preparation

In the context of preservice teacher preparation, this limitation indicates a gap in the literature regarding the explicit identification and understanding of the competencies required for managing virtual learning.

Furthermore, the study [42] emphasizes the immersive and interactive nature of the metaverse as a virtual environment for education. However, it falls short of providing a comparative analysis of the drawbacks associated with traditional virtual learning methods and the metaverse. Understanding the limitations and challenges of both approaches would provide a more comprehensive understanding of the benefits and potential drawbacks of using the metaverse for virtual education.

Similarly, [43] emphasizes the significance of competency-based approaches in enhancing virtual learning management. While their study outlines a framework for developing and accessing virtual learning competencies, it does not specifically address the integration of the metaverse into competency-based learning. Exploring the unique challenges and benefits of incorporating the metaverse into competency-based learning would enrich our understanding of how this virtual environment can enhance virtual learning management competencies.

The study conducted by [44], focuses on developing virtual learning management competencies among preservice teachers in the field of computer science. While the study highlights the potential of competency-based learning in a virtual environment, it does not specifically address the competencies needed within the context of the metaverse. Identifying the specific gaps in the development of these

competencies within the metaverse would provide valuable insights for future research and teacher training programs.

Lastly, the authors propose a comprehensive framework for competency-based learning in the metaverse. However, the study lacks empirical evidence and does not address the potential challenges and limitations of the proposed framework. Conducting a comparative analysis of the strengths and weaknesses of the framework would enable a more critical evaluation of its effectiveness in promoting competencies in virtual learning management.

In conclusion, while the reviewed studies contribute to the understanding of virtual learning management and the potential of the metaverse, they also have limitations. These drawbacks include a lack of focus on specific competencies, a need for comparative analysis between traditional virtual learning and the metaverse, an absence of exploration of the unique challenges and benefits of the metaverse in competency-based learning, and a lack of empirical evidence and critical evaluation in proposed frameworks. Addressing these limitations through future research would enhance the knowledge and practice of equipping preservice teachers with the necessary competencies to effectively manage virtual learning in the metaverse.

3 METHOD

This study employed a quasi-experimental design, in which the researcher conducted an experiment according to the research plan. The pretest and posttest designs used the one-group model [46] and were implemented as follows:

Table 1. Research plan

Group	Pretest	Treatment	Posttest
1	O_1	x	O_2
Time ▸			
1	Research participants		
O_1	Pretesting group (Pre-test)		
x	Competency-Based Learning on the metaverse		
O_2	Post testing group (Post-test)		

Table 1 shows the research plan, the pretest and posttest designs used the one-group model.

3.1 Sampling

This research employed purposive sampling to select 78 students from the computer learning management science and Educational Information Management courses. The sample included 38 first- and second-year students, as well as 40 third- and fourth-year students.

3.2 Data collection

Four testing and evaluation procedures were employed to gather participant information.

1. An activity aimed at promoting competency in virtual learning management on metaverse through a competency-based learning approach.
2. Achievement evaluation is a method used to measure knowledge in the field of computer learning and management science. This evaluation was developed by the researcher and consists of a 40-question multiple-choice test with four options.
3. Metaverse virtual learning management competency assessment.
4. A student satisfaction questionnaire on the enhancement of virtual learning management competency on metaversethrough competency-based learning.

3.3 Data analysis

The researcher then used all the data for statistical analysis to test the hypothesis and draw conclusions from the experimental results.

1. The researcher examined the quality of the research tool by utilizing statistics to assess its validity, difficulty values, discrimination, and reliability.
2. The reliability of the learning achievement test was calculated using the KR-20 formula.
3. A one-sample t-test was conducted to compare the competency of virtual learning management with a criterion of 70%.

4 RESULTS

4.1 Virtual learning management competency promotion activities

Virtual learning management competency promotion activities were conducted on metaverse using competency-based learning for a duration of 18 weeks. Through the appropriate evaluation of learning activities by three experts, it was determined that these activities were at the highest level (M = 4.60, SD = 0.50). The activities included the steps and components illustrated in Figure 1.

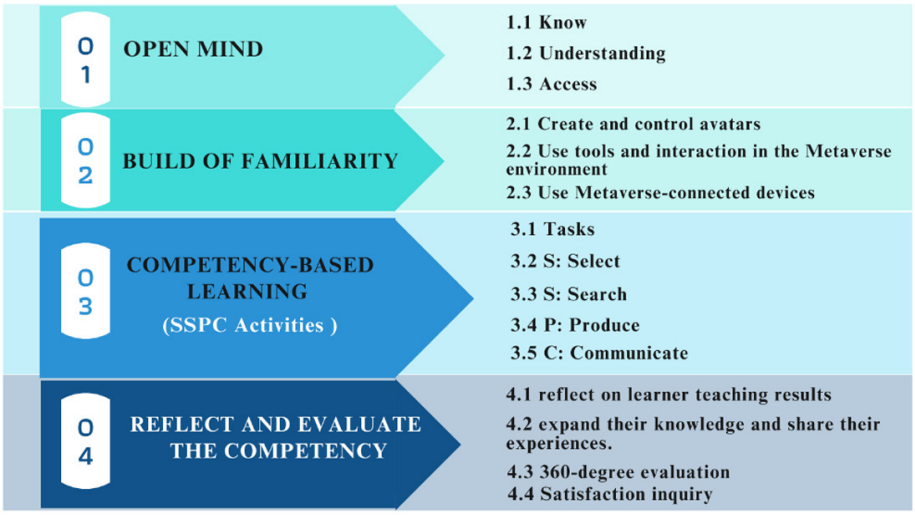

Fig. 1. Activity to promote competency of virtual learning management on metaverse with competency-based learning

Table 2. CBLAs to promote virtual learning management competencies on metaverse

<table>
<tr><th>Phase</th><th>Descriptions</th></tr>
<tr><td>Phase I: Open mind</td><td>This step involves a learning orientation that includes the following components:
1.1. Know: An introduction to the background, development, meaning, elements, educational applications, and a metaverse example.
1.2. Understanding: Creating an attitude of adaptability to learn new things and developing an awareness of the real and virtual world.
1.3. Access: Selecting the program to be used for creating the metaverse environment and providing knowledge about the tools and their usage.</td></tr>
<tr><td>Phase II: Build of familiarity</td><td>This step focuses on training and includes the following activities:
2.1. Creating and controlling avatars.
2.2. Using tools and interacting in the metaverse environment.
2.3. Utilizing metaverse-connected devices such as virtual reality (VR) glasses, computers, smartphones, and tablets.</td></tr>
<tr><td>Phase III: Competency based learning</td><td>This learning design consisting of
<table>
<tr><th rowspan="2">SSPC Activities</th><th colspan="2">Descriptions</th></tr>
<tr><th>Teacher</th><th>Student</th></tr>
<tr><td>Tasks are assignments that have an impact on the learning competencies set by the instructor.</td><td>1. Assign the task by specifying, “Students are required to create a virtual classroom and manage competency-based learning through Metaverse.io.”
2. Utilize SSPC activities and.io programs to educate and help learners understand the learning process.
3. Provide students with information about the tasks they need to complete.</td><td>1. Gain a comprehensive understanding of the mission.
2. Recognize and comprehend the processes involved in SSPC activities.
3. Recognize and understand the tasks to be performed during the event.</td></tr>
<tr><td>Activity 1 Selection (S stands for Select) allows learners to demonstrate the habit of picking the path that will lead to the assignment.</td><td>1. Assign each student one computer content to manage their study.
2. Requiring learners to choose the method of learning management that interests them in order to design their learning.</td><td>1. Choose one computer content.
2. Choose the method of learning management that is interesting to design the learning.</td></tr>
<tr><td>Activity 2 seek (S stands for Search) is a learning activity in which students seek for knowledge in a learning environment set by the teacher.</td><td>1. Using the Metaverse.io tool, create a virtual classroom and design a learning environment based on the course topic, mixing a variety of media, such as teaching materials download document Infographics, video clips, knowledge slides, worksheets, resource links, games, and quizzes.
2. Create a virtual classroom for group work, summarize information, and exchange learning amongst group members and teachers.
3. Schedule time for students to participate in activities, offer lectures to impart knowledge in class and distribute worksheets.</td><td>1. Participate in online virtual classroom activities by looking for and comprehending the body of information relevant to the students’ interests.
2. Participate in group activities online by summarizing knowledge and exchanging knowledge with group members and instructors.
3. Complete and submit work in accordance with the worksheet using the online channel designated by the instructor.</td></tr>
<tr><td>Activity 3 Produce a piece of work. (P stands for Produce) is an activity in which students create work based on the assigned task.</td><td>1. Motivate and guide learners to complete tasks such as:
1.1. Analyzing learning competencies.
1.2. Designing learning activities.
1.3. Developing competency-based learning plans.
1.4. Designing and constructing virtual classrooms.
2. Verify the accuracy of the work.</td><td>1. Evaluate the learners’ learning abilities using a specific computer content.
2. Design learning activities based on the learning management approach that interests the learners.
3. Develop a competency-based learning plan following the format provided by the teacher.
4. Design flowcharts and storyboards and create a virtual classroom using Metaverse.io.</td></tr>
<tr><td>Activity 4 Communicate (C stands for Communicate) is an activity in which students convey their assignments via media or online app.</td><td>1. Comment on the student’s presentation.</td><td>1. Manage the metaverse’s competency-based learning in accordance with missions.</td></tr>
</table>
</td></tr>
</table>

(Continued)

Table 2. CBLAs to promote virtual learning management competencies on metaverse *(Continued)*

Phase	Descriptions
Phase IV: Reflect and evaluate competency	This phase is Coaching, where the instructor observes teaching and analyzes the students' virtual learning management abilities. It consists of the following steps: **4.1.** Learners reflect on their teaching results. **4.2.** Teachers use observations to expand their knowledge and share their experiences. **4.3.** Evaluate virtual learning management competency using a 360-degree virtual self-assessment, instructor assessment, and peer evaluation. **4.4.** Evaluate the level of satisfaction with the learning activities.

Table 2 shows the four phases of competency-based learning that promote virtual learning

Competencies on metaverse:

Phase 1: Open Mind, consisting of 1.1) Know, 1.2) Understanding, and 1.3) Approach.

Phase 2: Build of Familiarity, consists of the following training modules: 2.1) Creating and controlling avatars, 2.2) Using tools and interacting in the metaverse environment, 2.3) Utilizing metaverse-connected devices such as VR glasses, computers, smartphones, and tablets.

Phase 3: Learn from competency-based learning activities, consisting of Activity 1: Select (S stands for select), Activity 2: Search (S stands for search), Activity 3: Produce (P stands for produce), and Activity 4: Communicate (C stands for communicate).

Phase 4: reflecting and evaluating competencies, consisting of 4.1) Learners reflect on their teaching results, 4.2) Teachers use observations to expand their knowledge and share their experiences, 4.3) Evaluate virtual learning management competency using a 360-degree virtual self-assessment, instructor assessment, and peer evaluation and 4.4) Evaluate the level of satisfaction with the learning activities.

The components of competency-based learning management can be summarized as follows:

1. Teachers are knowledgeable about learning management and classroom management, as well as the use of technology in education and promoting creativity. They are capable of analyzing and identifying learning capabilities, setting performance targets, designing activities, and assessing learning outcomes.
2. Learners: Every student has a unique personality, intelligence, aptitude, interests, and physical ability. Students should be given the opportunity to collaborate in their thinking, participate in the planning of teaching and learning, and have the chance to select from a variety of learning techniques as appropriate, under the supervision of the teacher.
3. Learning achievement implies: What are the students capable of? Determine what the learner should know in order to do so. As a result of determining core learning skills and regular content competency that are appropriate for learners, the instructor will be able to establish the goals and subject matter of learning, teaching management, and assessment and evaluation.
4. The content includes the knowledge, skills, attitudes, and characteristics necessary to achieve the desired competencies.

5. Competency-based learning assessments is a proactive learning management system that focuses on practice. It allows students to engage in the practical thinking process and receive suggestions to assist their knowledge application through various activities such as attending classes, reflecting, interacting with others, and learning from them. It includes skills for self-learning that inspire, which enable individuals to uncover their own potential to acquire information, comprehension, and competence based on their aptitude.
6. A competency-based learning plan is made up of three parts: OLE, which stands for objective learning activities and evaluation. Other characteristics of competency-based education include: 1) Learning objectives or outcomes must include desired competencies, 2) learning activities must focus on practical application, and 3) measurement and evaluation must encompass the assessment of necessary competencies.
7. Media, programs, and electronic devices that promote learning enable learners to enhance their performance by utilizing current and innovative media. These tools capture learners' interest, facilitate learning, and encourage proficiency in using digital technology and fostering creativity.
8. Performance-based evaluation: This method measures learners' practical skills by utilizing real-world assessments of their actions and their progress in performance, in relation to the established operational criteria.

4.2 The effectiveness index of virtual learning management and learning management performance

The following are the findings of research on the effectiveness index of virtual learning management competence promotion activities on metaverse, with a focus on competency-based learning.

Table 3. Results of the study on the effectiveness index of virtual learning management competency promotion activities on metaverse with competency-based learning

Student	Full Score	Pre-Test	Post-Test	Result Index	Percent
78	40	213	476	0.62	62

Table 3 shows the effectiveness index of the activities to enhance the ability to manage virtual learning in the metaverse is shown in Table 2, with the learning base performance equal to 0.62, or 62%. The students continued their learning journey by engaging in activities that enhanced their ability to navigate virtual learning. The performance-based approach is making rapid progress in education.

The results of the analysis comparing the performance of students in virtual learning management after school, using statistics (one-sample t-test) with a 70% criteria, showed the following findings:

Table 4. Shows the results of a comparative analysis on the performance of students in virtual learning management after school, using a 70% criteria

Experiment	n	Score	M	SD	Percent	*t*
Post test	78	20	4.25	0.48	84.91	6.25*

Note: *The *t* value is statistically significant at the level of .05.

Table 4 compares the performance of students in virtual learning management after school using a 70% criterion. The average score is 4.25 with a standard deviation of 0.48, which corresponds to 84.91% when compared to the 70% criterion. The t-value is 6.25, indicating that the performance level of the students' virtual learning management abilities after the study using the learning base exceeds the statistical significance threshold of 0.05 by 70%.

4.3 Students' satisfaction of learning activities

The results of the student satisfaction questionnaire regarding the learning activities to promote virtual learning management performance on metaverse with learning base competencies are as follows:

Table 5. Results of the student satisfaction questionnaire on learning activities to promote virtual learning management on metaverse with competency-based learning

Items	M	SD	Results
1. Managing Virtual Classroom Learning on Metaverse	4.59	0.50	Highest
1.1. Build confidence in the management of virtual classroom learning for students	4.53	0.64	Highest
1.2. Be aware of the problems that will arise during the virtual classroom learning management	4.47	0.74	High
1.3. Practice solving immediate problems during learning management	4.13	0.52	High
1.4. Practice using techniques to encourage learners to be interested in learning during online classes	4.53	0.52	Highest
1.5. Experience in teaching and learning in online classrooms	4.67	0.49	Highest
2. Learning through the Metaverse Program	4.34	0.65	High
2.1. The novelty of learning through avatars	4.40	0.63	High
2.2. Able to create an interesting classroom atmosphere	4.53	0.64	Highest
2.3. Enhance a new learning experience for students	4.73	0.46	Highest
2.4. Promote creativity	4.33	0.49	High
2.5. Able to communicate Send-Share-Save various formats	4.53	0.52	Highest
3. The results of the activities affect the students	4.63	0.49	Highest
3.1. Be able to analyze learning competencies	4.27	0.59	High
3.2. Be able to design learning with metaverse	4.60	0.51	Highest
3.3. Able to write competency-based learning plans	4.73	0.46	Highest
3.4. Able to manage virtual classroom learning	4.27	0.46	High
3.5. Able to evaluate learning outcomes	4.52	0.21	Highest
Average	**4.52**	**0.56**	**Highest**

According to Table 5, the students' satisfaction with learning activities to enhance their capacity to manage virtual learning in the metaverse with the average competency base, was highest (M = 4.52, SD = 0.56). When considering the highest average rating for each element, it was found that the influence of the activity on students was at the highest level (M = 4.63, SD = 0.49), ranking second. The management of

virtual classroom learning on the metaverse is rated at the highest level (M = 4.59, SD = 0.50), while learning through the metaverse program is rated at the third level (M = 4.34, SD = 0.65).

5 DISCUSSIONS

5.1 The CBLA to promote virtual learning management competencies in computer teacher students in the metaverse

Activities to promote the ability to manage virtual learning in the metaverse by learning the competency base consist of eight components, namely 1) instructor, 2) learners, 3) learning competencies, 4) content, knowledge, skills, attitudes, and characteristics, 5) CBLAs, 6) competency-based learning plans, 7) media, programs, and equipment, and 8) competency assessment. These activities aim to promote competency in virtual reality-based learning through four steps: Step 1: Open-mindedness, Step 2: Building familiarity, Step 3: Learning from competency-based learning activities, and Step 4: Reflecting and assessing competencies. Expert evaluators assess suitability at the highest level, and the effectiveness index of activities that impact student learning progress is high.

This is likely related to the fact that, according to David C. McClelland's view, the promotion of individual competencies is critical to the work's success. They consider performance to be a more significant indicator of job success than intelligence. It is clear that being a good student does not always guarantee success in employment. On the other hand, those who excel tend to be highly successful because they are able to employ the principles, methods, talents, and characteristics they possess to their advantage [10]. This finding is consistent with [7, 14, 47]. They stated that the level of effort will impact test results, leading to a higher score after the class compared to before. Moreover, the effectiveness of the activities has a significant impact on students' learning progress and the overall learning environment. Competency-based learning is designed to equip students with the skills to navigate the metaverse and build their confidence in using new technologies through competency-based learning activities. The system offers an easily understandable and practical hierarchy of information, along with reflection exercises and learning activities.

Students may analyze their thoughts, beliefs, attitudes, and actions in the context of a situation or experience to find a justification for their understanding of the situation or event. According to the study found that the procedure represents a systematic and transparent learning process [48]. It enables learners to understand the significance of their behaviors and attitudes, to influence change, and to put what they have learned into action. It can also lead to evaluations of learning management, both formative and summative. Learning the fundamental competencies is a tool for motivating students to accomplish their goals. The first step in the learning process is to define the learning competencies, followed by evaluating these competencies. This is also consistent with the study by [5]. They found that the competency-based performance of teachers must create a holistic vision for performance-based management that connects their professional needs to the development of teaching and learning abilities, as well as the monitoring of each student's progress. Along with designing a method to monitor learners' development, the use of emerging technologies, such as the metaverse, is particularly noteworthy. As a result, it is important to prepare students and teachers to effectively manage their

learning when it comes time to teach. The introduction of new technology is the first step in enabling students and teachers to access and understand the technology. This will help them develop an interest in experimenting with new tools to become familiar with them and gain experience, resulting in learning until they can summarize what they have learned and evaluate their performance. This is consistent with [49], who conducted research on the development of edu-metaverse ecosystems, including new and innovative frameworks, technological access, and equity. It is one of the primary influences on the metaverse learning environment.

5.2 The virtual learning management and learning management performance

At a significance level of 0.05, the findings of comparing students' virtual learning management competency after learning with the 70% criterion revealed that students' virtual learning management competency was significantly improved, exceeding the 70% threshold. This is consistent with the null hypothesis, which may be attributed to the fact that goal skills are specified in competency-based learning. The evaluation criteria for measuring competencies and learning outcomes have a defined purpose. As a result, students are prepared to study and take responsibility for achieving their goals. The finding is in line with [50], which investigated the assessment of competency-based education. It suggests that learners need to understand the scoring criteria, the examiner, and the purpose of the assessment. Learners must understand what is expected of them in order to prepare for assessing and optimizing their learning process, which includes competency-based learning management. The objective is for students to be able to put the acquired information, skills, attitudes, and qualities they have recently acquired into practice. To facilitate virtual learning in subjects that students find engaging, we can create a stimulating classroom in the metaverse, students to actively participate in their learning, solve problems in real-time, and gain practical experience before encountering similar scenarios in the real world. Virtual classroom simulations, according to [21], bridge the gap between theory and practice and facilitate student-teacher interactions in a controlled and secure environment compared to a traditional classroom. Students and lecturers will collaborate to address training deficiencies in order to enhance accuracy and facilitate effective communication in simulated scenarios. However, when measuring skills, it is important to use an assessment that is based on what students have actually practiced and is authentic. By employing rubrics as a framework for evaluating and assessing the quality of work or processes produced by students in response to the teacher's demands or expectations. According to [17], rubrics are a tool that helps assessors recognize the quality of an evaluation based on predetermined standards. In order to promote fairness and openness in the assessment process, it is important to prioritize stakeholder engagement, including competence assessment, in the evaluation of learners [50]. Therefore, this study used 360-degree feedback to evaluate student performance. As a result, information from multiple perspectives and experiences is gathered to help fill in the missing or distorted elements of the image. There will be more elements coming together to form a comprehensive picture than if only one assessor provides a limited or biased perspective [51]. Furthermore, according to [52], 360-degree evaluation is a participatory assessment approach. Once the assessment is completed, the feedback is shared with all stakeholders to ensure a clear understanding and perception of the evaluation. This promotes collaborative learning within the organization. When students are aware

of the competencies, objectives, assessment criteria, and learning outcomes of an assessment, it allows for a comparison of their virtual learning management abilities. This comparison is done at a significance level of 0.05, surpassing the 70% criterion.

5.3 The student satisfaction questionnaire results with learning activities

The evaluation of student satisfaction with the conducted activities found that students were extremely happy with the CBLAs on metaverse. This might be due to the fact that competency-based learning promotes real-world experience and teaches students how to manage competency-based learning. According to [5], this strategy aims to facilitate learning and track the progress of learners in the future, highlighting the need for teacher professional development in competency-based teaching. They survey and evaluate instructors who are enrolled in the Teacher Professional Development Program. Teachers were found to require professional development in various areas of expertise. In-depth knowledge of competency-based learning components, such as equity, meaningful assessment, personalized learning, cross-disciplinary skills, and the learning environment. This allows for the identification of jobs and promotes a shared understanding of how to execute competency-based learning. This also corresponds to [7, 14, 47]. The study on learning management to improve the competency of teacher students discovered that students' pleasure with learning in the classroom was also at its peak. Students stated that competency-based learning helped them to obtain the essential competencies in online teaching utilizing the metaverse, a current technology that can add information, and that the online classroom environment is fascinating and entertaining [53, 54]. However, students are still concerned about the use of program tools and their connection to VR headsets, which necessitates frequent practice sessions to attain proficiency [55]. These, along with [56, 57], stated that when students' perspectives on using metaverse for educational purposes were discussed, it was discovered that the majority of the students had never used metaverse before but desired to use the classroom setting on metaverse because the content was interesting and increasing motivation to study can improve knowledge. Furthermore, although metaverse is a successful teaching platform that enables real-life interactions and hands-on experiences to enhance 3D learning, there is hesitancy in its adoption. Some subjects are tough and complicated, making them unsuitable for augmented reality learning. Learning will be tough and distracting as a result of this, due to the importance of paying attention to the integration of various devices into the program, especially for student-teachers who want to integrate learning technologies, adequate professional development for student-teachers is required.

6 CONCLUSION

In summary, this study demonstrates that competency-based learning leads to students achieving their intended performance. However, teaching and learning in the metaverse is a new technology that students do not yet understand well and do not know how to use. Therefore, teachers must construct teaching and learning in such a way that students can adapt and learn effectively while also reducing learning anxiety. As a result, the promotion of virtual learning management competence activities in the metaverse, combined with competency-based learning, had a positive impact on the learning outcomes of teacher students.

This improvement in learning management and technological proficiency, including virtual classrooms, helps student instructors better understand what will happen in real-world teaching practice. It also leads to completing intended tasks, gaining new learning experiences, establishing a virtual classroom in the metaverse, and comprehending and freely accessing knowledge. This learning method is fun and exciting, promoting a globalized learning style. Teachers must integrate the metaverse into their teaching instead of relying solely on traditional methods. The limitations include students' limited familiarity with the metaverse, which can hinder their ability to adapt and learn effectively. Technical barriers, such as connectivity issues and software compatibility problems, can hinder the successful implementation of the metaverse in education. Additionally, teachers need to make significant pedagogical adjustments and receive adequate training and support to effectively harness the potential of the metaverse. While the study demonstrates the potential benefits of integrating competency-based learning in the metaverse, these limitations suggest the need for further research, teacher training, and infrastructure development to fully realize the advantages of virtual education.

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