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Development of a Learning Media Package on Orthographic Drawing Through the Metaverse

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ARTICLE INFO	ABSTRACT
	Orthographic drawing is fundamental in vocational education, yet conventional instruction often fails to engage students effectively. This study aimed to develop and evaluate a Metaverse-based learning media package to enhance vocational students' achievement. The package, consisting of six topics with interactive videos, peer communication, and exercises, was designed to increase engagement and comprehension. Its quality was reviewed by three experts and rated at a "very good" level (mean score 4.70, standard deviation 0.49). Effectiveness was tested using a post-test only design and by comparing learning outcomes between an experimental group and a control group. The results showed that the media met the efficiency criteria (E1/E2) at 82.31/80.13, and students who used the Metaverse media achieved significantly higher post-test scores than those in the control group (t = 3.67, p = 0.001). These findings indicate that Metaverse-based learning media is effective in improving vocational students' learning achievement and can serve as a practical model for developing innovative educational tools in technical and related fields. *Keywords: Development; Learning media package; Metaverse; Orthographic drawing*

1. Introduction

Currently, information technology plays a significant role in development across almost every field. It serves as both a primary and a supporting tool that must be provided and used in teaching and learning to align with the educational intent of the National Education Act. The direction and policies for Thai education management emphasize the use of important technology to a greater extent in education, though it is not meant to replace teachers entirely, but rather to help increase the efficiency of teaching and learning. One area where technology can assist Thai education is by providing access to content for teaching, not just in academic subjects but also in vocational ones [1]. Currently, a technology known as "Metaverse" is being widely used to create learning media.

The term "Metaverse" combines the words Meta and Verse, a fusion of virtual world technology that creates an environment of real-world and technology together. It allows people to interact and participate in joint activities through avatars, 3 D graphical representations of their true selves, to make them feel more like real life than the social media

used today [2]. Metaverse has an influence on the education sector, being applied in teaching and skill training. It integrates with the classroom, online, and social media to create a learning environment that promotes interaction and motivation, making it easier for learners to access learning content and acting as a stimulus for learning [3]. This also helps to improve learning achievement, especially for subjects that require a great deal of understanding, such as orthographic drawing. This is considered a fundamental subject of great importance for students in vocational education, particularly in the field of industrial mechanics, and specifically in the topic of orthographic drawing, where students have been found to lack knowledge and skills in reading blueprints. The factors affecting students' learning achievement are teaching media that lack interest and teaching methods that are mostly stuck in traditional frameworks or formats, which obstruct the change towards learning new things [4]. However, the integration of the Metaverse with education is a concept with the potential to innovatively change how we learn and teach. The use of the Metaverse to promote the learning management process helps create a virtual learning space. Learners can enter a created virtual world to experience learning in a context that connects to what they learn in real life. They have a learning experience linked to images and videos that provide clarity and interest. Learners can participate in creating content and learning experiences, such as designing learning scenarios, and can review knowledge or improve learning outcomes whenever they need to [5].

Based on the importance and problems, the research team conceived the idea of developing learning media by creating online learning media in the form of Metaverse on the topic of orthographic drawing, with the following research objectives: 1) Design and create a learning media package on orthographic drawing through Metaverse. 2) Evaluate the quality of the developed learning media. 3) Study the effectiveness of the learning media package. 4) Compare the post-test learning achievement of an experimental group, which used the learning media package via Metaverse, with a control group, which used conventional teaching methods. This is to help students better understand the content and enjoy new learning formats, enabling them to find knowledge anywhere, anytime, and helping to improve their learning achievement.

2. Materials and Methods

2.1 Scope of Research

2.1.1 Content scope

The content of the media package relates to the subject of Basic Drawing on the topic of Orthographic Drawing.

2.1.2 Research design

The research, which aimed to compare the learning achievement of the two groups, used a Randomized Control Group Posttest Only Design. The experimental design is shown in Table 1.

Table 1: Randomized Control Group Posttest Only Design

Group	Pre-test	Treatment	Post-test
ER	-	X_1	O_2
CR	-	-	O_2

Meaning of Symbols:

ER: Experimental Group
CR: Control Group
X_1: Teaching and learning using learning media through the Metaverse system on the topic of orthographic drawing
O_2: Post-test

2.1.3 Sample group

Experimental Group: 13 students from the second-year Vocational Certificate program in the Mechanical Engineering Technology Department, Samut Prakan Technical College. Control Group: 13 students from the second-year Vocational Certificate program in the Mechanical Engineering Technology Department, Samut Prakan Technical College.

2.1.4 Research instruments

The research instruments employed in this study comprised three essential components. First, a specifically designed and developed learning media package on orthographic drawing was constructed through the Metaverse system to serve as the core instructional tool. Second, a structured quality evaluation form was administered to examine the appropriateness, effectiveness, and overall pedagogical value of the developed learning media. Third, both in-class assessments and post-tests were employed to rigorously measure students' learning achievement in the domain of orthographic drawing.

2.2 Research Methodology

2.2.1 Study of relevant theories and research

This study examined the fundamental concepts and principles underlying the design and development of learning media within the Metaverse environment, with a focus on enhancing student engagement and learning outcomes. Relevant literature and prior research were systematically reviewed to identify best practices and theoretical foundations. These insights provided a coherent framework for the creation, implementation, and evaluation of Metaverse-based learning media, ensuring both pedagogical rigor and measurable educational effectiveness.

2.2.2 Design and creation of learning media on orthographic drawing through the metaverse system

The design and creation of the learning media on orthographic drawing through the Metaverse system was conducted through a systematic process consisting of five main steps. First, a content analysis was carried out to identify the key topics related to orthographic drawing and to establish clear instructional objectives. These served as the foundation for determining the lesson content as well as for the development of appropriate assessment instruments. Second, the consistency between the content and the predetermined objectives was examined by three experts, employing the Index of Item Objective Congruence (IOC) analysis. The results indicated that all topics achieved IOC values greater than 0.5, confirming the appropriateness of the content for integration into the learning media. Third, test items were created to align with the analyzed content and the set objectives, resulting in the development of a 14-item assessment. Fourth, the validity of the test items was further evaluated by three experts, again using IOC analysis. The findings demonstrated that all items exceeded an IOC value of 0.5, thereby affirming the suitability of the instrument for measuring students' learning achievement both during and after the instructional process. Finally, the learning media on orthographic drawing through the Metaverse system was developed with an emphasis on engaging instructional design, incorporating modern slide features, interactive games, and in-class activities. The completed media package was reviewed to ensure its comprehensiveness, coherence, and alignment with the intended learning objectives.

2.2.3 Quality evaluation of the learning media

The quality evaluation of the learning media on orthographic drawing through the Metaverse system was conducted by three experts specializing in instructional design and engineering graphics. The evaluation process examined four key dimensions: content presentation, media package components, media usability, and presentation management. The experts rated each aspect using a standardized five-point Likert scale. The results indicated that the overall quality of the learning media achieved a mean score of 4.70 with a standard deviation of 0.49, which is interpreted at a "very good" level according to the established evaluation criteria. When considered individually, content presentation obtained a mean score of 4.61 (S.D. = 0.49), media package components scored 4.89 (S.D. = 0.31), media usability was rated at 4.47 (S.D. = 0.62), and presentation management received a mean score of 5.00 (S.D. = 0.00). These findings affirm that the designed learning media demonstrated high quality across all evaluated dimensions, thereby ensuring its suitability for implementation in enhancing students' learning achievement in orthographic drawing.

2.2.4 Experiment implementation

The implementation of the experiment followed a systematic procedure to ensure methodological rigor. Initially, all students in the sample group were administered a preliminary knowledge test on orthographic drawing in order to assess their prior knowledge levels. Based on these results, purposive random sampling was employed to categorize the students into two groups while maintaining balance in terms of knowledge levels. Accordingly, 13 students were assigned to the control group, and another 13 students were assigned to the experimental group, following the principles of the Randomized Control Group Posttest-Only Design. Subsequently, the experimental group received instruction through the developed learning media on orthographic drawing utilizing the Metaverse system, whereas the control group was taught through conventional teaching methods. At the conclusion of the instructional period, both groups administered a post-test in accordance with the experimental design to measure and compare learning achievement.

Examples of the experimental group taught using the learning media on orthographic drawing through the Metaverse system are shown in Fig. 1 (a), (b).

(a)   (b)

Fig. 1: (a), (b) The experimental group taught using the learning media on orthographic drawing through the Metaverse system

2.2.5 Data collection

Scores from the in-class tests for each topic and post-test scores for both the experimental and control groups were collected for analysis.

2.2.6 Analysis of experimental results

The efficiency of the media package was analyzed to find the E1/E2 values. The comparison of post-test learning achievement between the experimental and control groups was analyzed using an Independent Sample t-test to compare the difference between the mean scores of the two groups.

3. Results and Discussions

The study developed a Metaverse-based learning media package on orthographic drawing, structured into six interconnected topics encompassing conceptual foundations, principles of projection, planes and projection angles, spatial interpretation, and line projection techniques. Each topic incorporates self-paced video lectures, interactive peer activities, and practice exercises, ensuring alignment with learning objectives and promoting active engagement.

Quality assessment conducted by three experts across four dimensions, content presentation, lesson components, usability, and presentation management, yielded a mean score of 4.70 out of 5 (SD = 0.49), indicating very good overall quality. Efficiency evaluation based on in-class and post-test scores of 13 experimental students showed averages of 82.31% and 80.13%, respectively, meeting the established 80/80 criteria. Comparison of post-test results

between the experimental group (mean score = 10.23, SD = 1.37) and the control group (mean score = 7.85, SD = 1.79) revealed a statistically significant difference (t = 3.67, p = 0.001), demonstrating that Metaverse-based learning significantly enhanced student achievement. Examples of the learning media on orthographic drawing through Metaverse are shown in Fig. 2 (a-d).
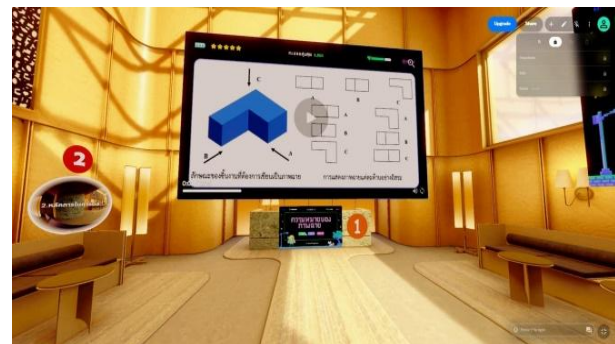

(a)

(b)

(c)

(d)

Fig. 2: (a-d) Examples of the designed and created Metaverse-based learning media on orthographic drawing, (a) the homepage for accessing lessons within the Metaverse environment, (b) the interface for selecting subtopics for learning within the Metaverse environment, (c) the section for entering lessons within the Metaverse environment, and (d) the assessment module within the Metaverse environment

These findings reflect the potential of Metaverse technology to create an immersive and interactive learning environment that emphasizes student engagement and self-paced learning [6]. The significant improvement in the experimental group's performance supports its suitability for teaching orthographic drawing, particularly for content requiring spatial reasoning and comprehension of two-dimensional representations. Consistent with the theoretical framework proposed by Sujitwanich and Vichayawong [7], effective learning media should be systematically designed, multimedia-integrated, and capable of fostering self-directed learning. The developed media adhered to these principles, ensuring clear content presentation, appropriately challenging activities, and systematic evaluation, thereby enabling students to gain a deep understanding and apply knowledge in practical contexts.

Moreover, the results align with 21st-century learning management principles, which emphasize the development of critical thinking, problem-solving, information literacy, and lifelong learning [8-9]. By facilitating independent exploration of complex content and participation in student-centered virtual activities, the Metaverse environment promoted active knowledge construction and higher-order cognitive skills. Its interactive and engaging features also resonate with the recommendations of Tarnphaew et al. [10], emphasizing that learning media should be appealing, user-friendly, and conducive to continuous participation. The development process followed Pimaikul's systematic production framework [11], encompassing learner analysis, objective setting, activity design, media creation, testing, and refinement, ensuring both efficiency and educational effectiveness.

In conclusion, the Metaverse-based learning media demonstrated high quality, operational efficiency, and a significant positive impact on students' learning outcomes in orthographic drawing, highlighting its potential as an innovative tool for modern technical education.

4. Conclusion

The research successfully designed and created a Metaverse-based learning media on orthographic drawing, consisting of six learning topics, with an overall quality level rated as very good and media efficiency that met the established E1/E2 criteria at a level of 82.31/80.13. Additionally, it resulted in students who learned with the Metaverse-based learning media on orthographic drawing having a statistically significantly higher learning achievement than the group that learned with conventional methods at the 0.05 significance level. The results of this research, therefore, show that the Metaverse-based learning media on orthographic drawing can be used as a guideline for developing learning media related to drawing and other topics in the future.

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