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Enhancement of Students' Learning Outcomes on the Experiential Design Thinking Learning Platform with Metaverse

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Abstract. The Experiential Design Thinking Learning Platform with Metaverse (EDTL Platform) integrates experiential learning, design thinking and metaverse technology to create learning environments that enhance vocational students' teamwork and problem-solving skills in Thailand. The main objectives are to explore the perspectives on the development of the learning platform after being put in practical use, and to see whether it can improve teamwork skills and problem-solving skills of learners. Thereby, the study employs the pre-experimental research method conducted with seven experts and 30 vocational certificate freshmen. The research instruments include: 1) the EDTL Platform with Metaverse; 2) the evaluation form on the quality of the platform; 3) the measurement form on learning achievement; 4) the evaluation form on teamwork skills; 5) the evaluation form on problem-solving skills; and 6) the satisfaction assessment form. The findings indicate that the EDTL Platform enhances learners' teamwork and problem-solving skills while promoting self-directed learning and knowledge acquisition through digital technology. However, there are still some research gaps that need further study. For example, future research should be conducted with a larger and more diverse sample group by including students from other institutions following different academic programs from various regions. This is to ensure that the research findings can be applied more broadly.

Keywords: experiential design thinking learning; metaverse; teamwork skills; problem-solving skills

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1. Introduction

Currently, Thailand's vocational education system under the Vocational Education Curriculum B.E. 2567, comprises Vocational Certificate (Voc. Cert.) and High Vocational Certificate (High Voc. Cert.) Programs. These curricula have often been updated, modernized and aligned with the needs of the labor market and the rapid development of technologies. The education system focuses primarily on developing students' knowledge, skills and attitudes that are essential for specific careers.

The emphasis is placed on practical training to address varied working conditions so that students are able to practically apply their knowledge and skills to their future careers as to professional standards (Office of the Vocational Education Commission [OVEC], 2024). In general, vocational education aims to equip students with the knowledge, skills and attitudes needed for employment. However, the current instructional approaches often fail to provide the practical workplace experience required to develop job-specific skills. As a result, most vocational students today still lack the real workplace experiences and such important skills (Trongtorsak et al., 2021; Wongchai, 2021) as communication skills, teamwork skills, problem-solving skills, etc.

Previous research has demonstrated that the hands-on activities found in experiential learning and design thinking can promote self-directed learning, improve conceptual understanding and increase engagement in learning, all of which are said to result in better learning outcomes (Chatwattana et al., 2023; Che, 2026; Sisamud et al., 2025). Although many previous studies have explored the application of theories of experiential learning and design thinking, there are also some research gaps regarding the integration of these theories with metaverse technologies in vocational education.

Vocational education aims to equip students with the knowledge, skills and attitudes required for employment through contemporary learning approaches, interactive activities and effective teaching strategies. However, these approaches often provide limited opportunities for authentic workplace experience. To address this gap, this study explored the use of an experiential design thinking learning platform with the metaverse (EDTL Platform), which has been shown to enhance cognitive, problem-solving and teamwork skills through immersive, experience-based learning. The study examined stakeholders' perspectives to determine the platform's quality and practicality in developing learners' teamwork and problem-solving skills. Thus, the objectives of this study were as follows:

1.1 Research Objectives

RO1: To synthesize the learning activities in the EDTL Platform with Metaverse.
RO2: To develop the EDTL Platform with Metaverse.
RO3: To determine the results of using the EDTL Platform with Metaverse.

1.2 Research Hypotheses

RH1: The quality of the developed EDTL Platform with Metaverse is at high level.
RH2: The post-test scores of the students, who studied with the EDTL Platform with Metaverse, are significantly higher than the pre-test scores with statistical significance at .01 level.
RH3: The teamwork skills of the students are at good level after learning with the learning platform.
RH4: The problem-solving skills of the students are at good level after learning with the learning platform.
RH5: The satisfaction after using the learning platform is at high level.

2. Literature Review

Vocational education in Thailand has been modernized on a regular basis so as to make it align with the demands of labor market and catch up with the rapidly changing technologies. To illustrate, the vocational education system places an emphasis primarily on the improvement of students' knowledge, skills, and attitudes that are indispensable for specific occupations. Moreover, greater emphasis has also been placed on practical training and work environments in real life. For example, most instruction systems today focus more on the real workplace experience, communication, teamwork, problem-solving, and actual work systems within workplaces. This has resulted in the new and modern learning processes that can promote practical skills and develop positive attitudes to lifelong learning. The following theories assist in identifying the concepts related to vocational education:

2.1 Experiential Learning

Experiential learning refers to a learning model that encourages learners to conduct self-directed learning with practical application. In this way, learners shall face challenges and gain direct experiences, which results in the creation of new bodies of knowledge. Kolb (1984) proposed the theory that comprises four stages of learning cycle called the Experiential Learning Model, including concrete experience, reflection observation, abstract conceptualization, and active experimentation. Experiential learning is the process through which adults develop knowledge and skills from lived experiences, interactions with their environment, work, education and personal development, building new knowledge on existing understanding (Wongchai, 2021). Practical application involves addressing real-world challenges and experiences, enabling learners to apply new knowledge, refine their understanding and build on existing knowledge in relevant contexts (Chatwattana et al., 2023).

A review of the literature on experiential learning and knowledge management in higher education (Chatwattana et al., 2022; Chatwattana et al., 2024) suggests that integrating these approaches with modern technologies can support the development of innovative teaching platforms. Such platforms can enhance instructional design and promote continuous, independent and experience-based learning suited to the demands of the New Normal (post-COVID-19) era. They are designed to prepare learners for real-world challenges by providing authentic learning experiences through the effective use of digital technologies.

2.2 Design Thinking

Design thinking is an important approach to learning because it encourages learners to develop innovative solutions and solve problems systematically through creative thinking (Sisamud et al., 2025). Moreover, design thinking is in line with the 21st-century learning skills that learners ought to have. Vocational students need strong design thinking and innovation skills to succeed in the workplace, as these skills enable them to develop innovative solutions and solve real-world problems. Design thinking promotes cognitive learning and computer-aided design, enabling learners to develop innovative solutions and create new products (Phunaploy et al., 2021).

At the same time, this concept can help increase work efficiency, enhance knowledge and experience, and develop technology skills that are in high demand in this modern era (Yedra & Aguilar, 2022). The design-thinking process consists of five steps (Guaman-Quintanilla et al., 2023; Sisamud et al., 2025), namely, empathize, define, ideate, prototype and test. A review of the literature on design thinking (Phunaploy et al., 2021; Sisamud et al., 2025) suggests that it can be integrated into education to increase learner engagement by encouraging brainstorming, data collection and creative problem-solving. At the same time, digital technology, which is believed to support lifelong learning, can be used in instruction management.

2.3 Experiential Design Thinking Learning

Experiential design thinking learning (EDTL) refers to the concept that integrates the four stages of experiential learning (i.e., concrete experience, reflective observation, abstract conceptualization, and active experimentation) with the five steps of design thinking (i.e., empathize, define, ideate, prototype, and test) in an attempt to create a learning model that can satisfy the needs of vocational students who lack work experience. EDTL is a learning management approach that encourages students to apply design thinking while developing workplace-related knowledge and skills through authentic learning experiences (Guaman-Quintanilla et al., 2022).

This learning model uses virtual technology to enable students to access learning content, explore digital technologies and use a range of tools within a virtual learning environment. All these experiences and knowledge can be applied to their future careers and in the real workplace. Not only that, but learners can also develop important skills through the EDTL, for example, teamwork skills and problem-solving skills (Vardakosta et al., 2023). The EDTL process consists of six steps, namely, (1) experiential empathic; (2) reflective definition; (3) conceptual ideate; (4) experimentation prototype; (5) active experimentation; and (6) iterative testing (Saeliang et al., 2026).

2.4 Metaverse

Metaverse refers to a virtual platform that integrates the real world and the virtual world through the creation of interactive digital 3D visualizations by means of various technologies, such as virtual reality and augmented reality. Because of its ability to provide virtual experiences, metaverse technology can be employed effectively in various formats of learning management in vocational education;

for instance, it can be used to create simulations of factory work, facilitate practical training related to the use of tools and machinery, and develop professional skills in safe environments before entering real work (Tasen et al., 2024). It is believed that the application of metaverse technology in vocational education can also offer opportunities for students to prepare themselves for the labor market in different industries and businesses. This is because such technology has the potential to enhance the ways of training, develop students' skills, and provide simulated work experience. All of these can provide them with realistic, engaging and practical learning experiences that can be effectively applied in real work situations (Thongprasit & Piriyasurawong, 2023). The metaverse can be applied in teaching, training and organisational development by providing realistic, interactive and flexible learning experiences that meet users' specific needs (Kongna & Srilapo, 2023).

In the education sector, research on the potential of metaverse technologies is flourishing. There are more aids for language learning, e.g., AI bots, ambient intelligence, and metaverse, some of which have already become indispensable in our daily lives (Godwin-Jones, 2023; Hu et al., 2026;). The overview of the theoretical concepts and literatures relevant to metaverse (Netniyom et al., 2025; Sapliyan et al., 2023) indicates that the metaverse can be integrated into education to facilitate the learning process, by giving learners access to self-directed learning and immersive learning experiences in digital learning environments.

Although metaverse-based learning can improve learning outcomes by providing immersive and realistic learning experiences, its implementation may be limited by the digital literacy of students and instructors and the lack of metaverse platforms designed for specific learning needs, such as vocabulary development (Li & Yu, 2023; Wu et al., 2024). Greater emphasis should be placed on the use of metaverse technologies and the experiences gained therefrom (Rosendahl & Wagner, 2024). It is necessary to undertake empirical studies on this field in order to promote the application of metaverses in educational contexts (Hu et al., 2026).

2.5 Teamwork Skills

Teamwork skills refer to the abilities of a group of people who share a common purpose and are committed to working in a team with the aim of achieving a task or goal. In effective teams, the team leader encourages all members to participate in decision-making and to share responsibility for achieving agreed goals (Siburom & Sriklaub, 2023). At the same time, while carrying out the tasks in a systematic and formal manner, all members are jointly responsible for the outcomes (Thunyaharn et al., 2024). There are five elements of teamwork skills (Klinmalee, 2022), namely communication, collaboration, responsibility and accountability, collaborative problem-solving discussions, and adaptability and flexibility.

2.6 Problem-Solving Skills

Vocational education under the supervision of the OVEC emphasizes the enhancement of students' professional skills so that they have competencies aligned with the demands of today's labor market. Furthermore, education of this kind places particular significance on the development of problem-solving skills in order to prepare learners for the upcoming changes and challenges, especially those found in the dynamic working environments. Generally, the curricula of OVEC focus on the improvement of students' problem-solving abilities, applying cutting-edge technologies to create modern and highly flexible learning experiences (OVEC, 2021). Effective problem-solving requires individuals to draw on a range of cognitive and personal skills, including memory, perception, reasoning, communication, motivation and self-confidence, to identify the underlying causes of problems. After that, they must establish clear approaches and procedures to provide solutions to problems, which will eventually lead to tangible results (Badriah et al., 2023; Tupthong & Chatwattana, 2025).

Problem-solving skills are the ability to apply logical thinking and creativity to understand situations and develop effective solutions. These skills are strengthened through experience, observation, data collection, analysis, interpretation and drawing conclusions (Sangwan & Singh, 2022). All these skills are said to lead to rational problem-solving. In addition, problem-solving skills are related to the ability to develop and evaluate alternative solutions in order to determine the optimal ones (Guaman-Quintanilla et al., 2023). Based on previous research and theories on problem-solving skills (Guaman-Quintanilla et al., 2023; Mahanal et al., 2022; Muangsong & Doungwilai, 2024; Polya, 1945; Saeliang et al., 2026), the researchers identified the following indicators of problem-solving skills:

(1) Problem identification, which is the analysis and interpretation of the problem in order to understand its core essence clearly.
(2) Problem analysis and solution generation, which refers to the step of investigation and analysis on the problem so as to find out its components.
(3) Planning for problem-solving, which is about the establishment of explicit guidelines and steps that can solve the problem effectively.
(4) Implementing the plan, which refers to the stage of putting the problem-solving plan derived from the earlier step into practice by using skills and resources efficiently to achieve the desired results.
(5) Evaluating and refining the solution, which involves the analysis and examination on the effectiveness of the solutions to improve the approaches further.

The thorough examination of the overall related concepts, theories, and literature has resulted in the guidelines to define the conceptual framework and relevant theories as shown in Figure 1.

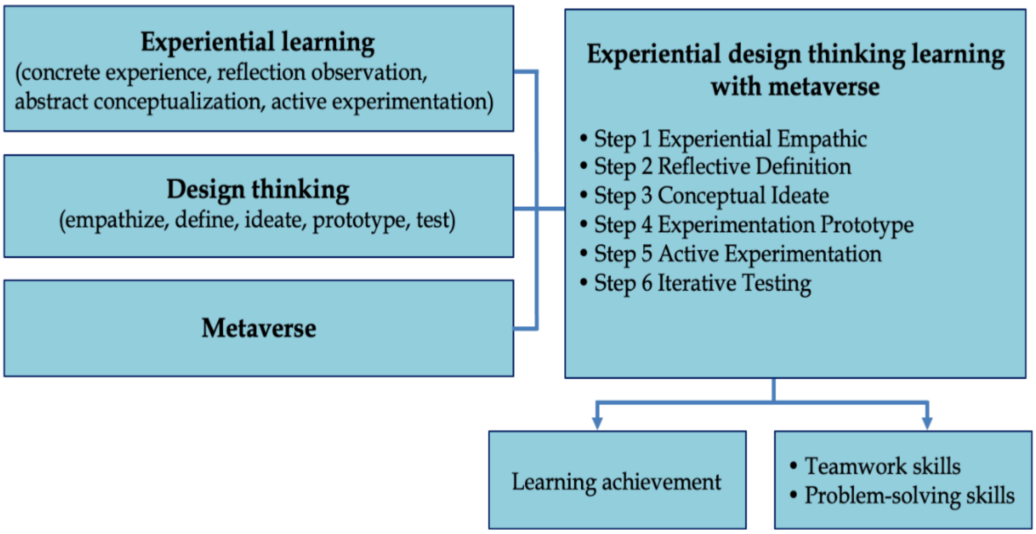

Figure 1: Conceptual framework and related works

3. Materials and Methods

The development concept of the EDTL Platform with Metaverse is based mainly on the systems approach, which is focused on designing and developing the instructional systems with sequential structures and components (Khemmani, 2018; Utranan, 1982). This study uses the pre-experimental research method based on a one-group pre-test-post-test design. Owing to the limitation of the small sample, in which all the students were studying in the same institution, it was not possible to include a control group in this study. This study examined the effects of the developed learning platform on students' learning achievement, teamwork skills and problem-solving skills. In addition, the research design had other limitations; for example, the researchers were unable to control all external factors that could affect the outcomes, including time and the results of repeat tests.

In order to test all five research hypotheses, a statistical test was performed to check whether the mean of the single sample group, which had been measured twice, was significantly different or not (Srisa-Ard, 2013). The approaches to determining the results were as follows:

To answer the Research Hypothesis 1 (RH1), the researchers synthesized the learning components and the learning process and then used them as guidelines to develop the EDTL Platform with Metaverse that could be put to practical use. This was to determine whether the said platform could enhance teamwork skills and problem-solving skills or not. Regarding the assessment on the quality of this platform, the researchers conducted a survey using a 5-level Likert scale evaluation questionnaire, which contained 26 items for evaluation covering all four aspects of the platform, i.e., content, design, efficiency, and practical use. The details of the 26 items concerned the quality of different elements in the platform. This was to examine to what extent the learning process could be practically applied to improve the students' teamwork skills and problem-solving skills.

To test Research Hypothesis 2 (RH2), the researchers implemented the learning platform with 30 participants selected through cluster sampling. All these participants are the High Vocational Certificate freshmen from Pongsawadi Technological College, enrolled in the subject of Computer Network Management. Participants completed a 30-item, four-option multiple-choice pre-test and post-test to assess whether learning achievement improved after using the developed platform.

In order to answer the Research Hypothesis 3 **(RH3)**, the researchers assessed the teamwork skills of these students after letting them study with the platform. The assessment was conducted by means of an authentic assessment based on a 4-level rubric score, on which the assessment criteria for teamwork skills ranged from “Needs Improvement” to “Excellent”. This was aimed at determining whether the participants’ teamwork skills scores after learning with this platform were at an acceptably high level or not.

To test Research Hypothesis 4 (RH4), participants' problem-solving skills were assessed after using the learning platform with an authentic assessment based on a 4-level rubric ranging from “Needs Improvement” to “Excellent.” The objective was to determine whether the problem-solving skills scores of these students after learning with this platform were at an acceptably high level or not.

To test the Research Hypothesis 5 (RH5), the researchers conducted a satisfaction assessment after using the said learning platform to explore the students’ satisfaction toward this platform. The 5-level Likert scale evaluation form, containing 20 questions, was used in this process in order to determine whether the overall satisfaction with this learning process was at high level or not.

3.1 Participants and Ethical Considerations

The participants in this research were divided into two groups. The first one consisted of seven experts from different institutions, all of whom were highly experienced in vocational education management and design and development of instructional platforms. The experts were purposively selected based on their minimum of seven years' experience in education and instructional systems design and development.

Each was approached individually and provided with informed consent to participate in the study. These experts were responsible for assessing the learning platform in terms of its quality and efficiency before having it tested by the students in the other sample group. The other group of research participants, obtained by means of cluster sampling, comprised 30 vocational certificate freshmen from Pongsawadi Technological College. All participants in both groups needed to be in good health and proficient in speaking, listening, reading and writing Thai. Moreover, they needed to have experience in using online platforms and be familiar with digital technology.

This study adhered to rigorous ethical guidelines according to international research standards, i.e., Declaration of Helsinki, The Belmont Report, CIOMS Guidelines, and the International Conference on Harmonization in Good Clinical Practice (ICH-GCP). This study also received authorization from the University

Ethics Committee and the thesis advisers who had at least five years' expertise in educational technology. The study was regarded as a research project with low risks for the participants. It involved tests of general behavioral in the short term, which posed no danger and did not collect data that could identify the participants. Nonetheless, the researchers conducted the study in strict compliance with the ethical guidelines based on the identified research standards. The participants were the information about the research before being asked for the consent to take part. All data were collected anonymously and stored on a password-protected drive, while the results were reported only in aggregate format. Most importantly, access to the data was limited only to the researchers.

3.2 Instruments and Data Collection

The data collection tools used in this research included:

(1) the EDTL Platform with Metaverse;
(2) the 5-level Likert scale evaluation form on the quality of the learning platform, which contained 26 items of evaluation on the four aspects of this platform, i.e., content, design, efficiency, and application for practical use;
(3) the pre-test and post-test measurement form on learning achievement consisting of 30 multiple-choice questions (four options);
(4) the evaluation form on teamwork skills obtained from learning activities within the developed platform, using the 4-level rubric score system for authentic assessment;
(5) the evaluation form on problem-solving skills obtained from learning activities within the developed platform, using the 4-level rubric score system for authentic assessment; and
(6) the 5-level Likert scale evaluation form on satisfaction with this learning platform, which contained 20 questions.

The data analysis was carried out by means of descriptive statistics, using mean (M) and standard deviation (SD). Differences between the pre-test and post-test scores were analyzed using a paired-samples *t*-test. This was to see whether there were significant differences from the hypothesized mean (one-tailed, alpha = .01); with a confidence interval of 99 percent. Before data collection, qualified experts evaluated all data collection instruments, including the platform quality evaluation form, learning achievement test, and teamwork and problem-solving assessment rubrics, using the Index of Item-Objective Congruence (IOC) to establish content validity. The instruments demonstrated excellent validity and reliability, with IOC values ranging from 0.93 to 1.00 and Cronbach's alpha coefficient of 0.923. The learning achievement test also showed acceptable item difficulty (0.20–0.80) and discrimination indices (0.20–0.60).

3.3 Methods

This study was intended primarily to explore the overall perspectives on the development of the EDTL Platform with Metaverse, which was designed to promote teamwork skills and problem-solving skills, and to examine the five research hypotheses. The study relied mainly on the pre-experimental research method using a one-group pre-test/post-test design. The approaches for developing the said learning platform were based on the systems approach (Khemmani, 2018; Utranan, 1982) and SDLC techniques (Robert et al., 2013).

The research methodology can be summarized into three phases as below:
Phase 1: Synthesize the learning activities for use as guidelines to determine the learning process in the EDTL Platform with Metaverse.

Phase 2: Develop the EDTL Platform with Metaverse. In this phase, the researchers employed the concepts of the systems approach integrated with the principles and techniques of SDLC to develop the said learning platform with the aid of Spatial.io platform, which enables learners to learn on their own anywhere and at any time. It was expected that the helpful features of this learning platform would encourage learners to gain novel experiences from virtual learning environments. In addition, the learning style was believed to promote self-directed learning that could be performed through interaction and collaborative activities on the virtual platform. All these could lead to the more effective learning and enhancement of essential skills among learners.

Phase 3: Study the results after learning with the EDTL Platform with Metaverse: All the research participants gave their consent to participate in this study phase, which was aimed primarily to test the five research hypotheses. The criteria and interpretations of the 5-level scale assessment model employed in this study were based on those devised by Srisa-Ard (2013).

4. Findings and Discussion

The results of the design and development of the experiential design thinking learning platform with metaverse, or EDTL Platform with Metaverse, were divided into three phases:

4.1 Phase 1: Synthesis of Learning Activities

The researchers studied and analyzed the documents and previous research concerning the design and development of the EDTL Model with Metaverse (Saeliang et al., 2026), and then synthesized the learning processes, learning activities, tools/technologies, evaluation criteria, and learning outcomes to be used as guidelines for designing the learning activities in the platform developed herein. The details are illustrated in Table 1.

Table 1: Learning activity plan in the EDTL Platform

Learning process	Evaluation	Learning outcomes
Step 1: Experiential Empathic		
1. The instructor asks the students to form groups of 4-6 people and assigns worksheets to them. 2. The students form their groups and assign tasks to their members. 3. The instructor provides examples of some works produced from the worksheets.	1. The evaluation form on teamwork skills 2. The evaluation form on problem-solving skills 3. The observation form on learning behavior of individuals	The students are able to observe, collect data, and understand the contexts of stakeholders without being forced to assume anything beforehand, so that they can obtain perspectives, reflections, and contexts from users as empirical evidence.

Learning process	**Evaluation**	**Learning outcomes**
Step 2: Reflective Definition		
1. The instructor explains how to use the tools for data analysis and synthesis, and how to prioritize the data. 2. The students collaboratively synthesize the data and explain their needs as to the priority of data.	1. The evaluation form on teamwork skills 2. The evaluation form on problem-solving skills	The students synthesize experiential data, find out and prioritize their tangible needs, and then provide evidence-based reasonings.
Step 3: Conceptual Ideate		
1. The students present their ideas and options in correspondence to their evidence-based needs.	1. The evaluation form on teamwork skills 2. The evaluation form on problem-solving skills 3. The monitoring form on the assignment	The students are able to think creatively, generate different options, and connect their ideas with shared evidence-based requirements.
Step 4: Create Prototype		
1. The instructor explains how to use the design and development tools in order for the students to foster creativity and find out their design options. 2. The students work in groups to transform their ideas into concrete design and developing the project. 3. The students collaboratively design a methodology for testing the completed project.	1. The evaluation form on teamwork skills 2. The evaluation form on problem-solving skills 3. The post-test evaluation form	The students can transform their ideas into concrete forms, give reasons for their design, and prepare for the testing through hands-on practices.
Step 5: Active Experimentation		
1. The students design and develop their group project, conduct systematic testing, collect qualitative and quantitative data, and then summarize the results thereof. 2. The students collect data derived from the tests so as to create their project presentation for the instructor to do assessment. 3. The instructor evaluates the project of each group.	1. The evaluation form on teamwork skills 2. The evaluation form on problem-solving skills 3. The evaluation form on the assignment	The students are able to design and perform testing systematically, collect both qualitative and quantitative data, and draw factual conclusions for future improvement.

Learning process	Evaluation	Learning outcomes
Step 6: Iterative Test		
1. The instructor explains the testing process, data collection, and improvements to ensure the project's efficiency and completion before delivering it to users. 2. The students conduct the testing, collect data, and make improvements to make their project complete, and then deliver it to users.	1. The evaluation form on teamwork skills 2. The evaluation form on problem-solving skills	The students practice the processes of testing, data collection, and improvement in order to demonstrate quantitative and qualitative improvements during testing cycles and meanwhile develop their practical thinking skills.

Table 1 illustrates the synthesis of the learning activity plan on the learning platform, in which the activities were conducted for five hours per week for four weeks. To ensure the reliability of the data, the researchers synthesized the EDTL process, the details of which were described in previous research (Saeliang et al., 2026). This synthesis was based mainly on the study of theories and approaches related to the four stages of experiential learning (Kolb, 1984; Wongchai, 2021), and design thinking process, which consists of five stages (Guaman-Quintanilla et al., 2023; Sisamud et al., 2025). This was to identify the recurring themes regarding the approaches, steps and supporting factors of learning outcomes, which were all interconnected. Every effort was made to ensure that all six steps of the learning process in the learning activity plan were appropriate for the platform.

The learning activities can be summarized as follows:

- Step 1. Experiential Empathic: Regarding the learning activities in this step, the instructor divided the students into small groups and assigned them worksheets. Students allocated tasks among group members and collected data on users' needs and workplace challenges presented in the developed platform.
- Step 2. Reflective Definition: In this stage, the instructor explained how to use the tools and technologies in the platform, and allowed the students to study, consider, observe and reflect on their experiences in order to synthesize further information based on the experiences.
- Step 3. Conceptual Ideate: The learning activities in this part mostly involved the students' collaborative brainstorming in the attempt to seek solutions. The instructor listened to the challenges encountered during the process and provided guidance and constructive feedback.
- Step 4. Create Prototype: This was a process of creating and applying the new ideas, derived from collaborative brainstorming among the team members, to real situations in order to design and develop the project. During this process, the instructor observed the students' behavior while assessing their teamwork skills and problem-solving skills.
- Step 5. Active Experimentation: The students implemented the working plan by conducting systematic testing on the created project. Both qualitative and quantitative data were collected, and the findings were summarized for

further improvement. The instructor monitored the students' progress, observed their behavior, and then evaluated their teamwork skills and problem-solving skills.

- Step 6. Iterative Testing: During these activities, the students evaluated and refined their problem-solving approaches to make them more effective and then determine more appropriate and practical solutions. The instructor helped them by providing additional explanations about the processes of experimentation, data collection, and improvement in order to ensure that the project became more efficient and complete before putting it into practical use by users.

4.2 Phase 2: Development of the EDTL Platform with Metaverse

The EDTL Platform with Metaverse supports practical, self-directed learning by enabling learners to access internship-related content and workplace experiences anytime and anywhere. Furthermore, the functionalities supported by the Spatial.io, as well as the aid of enhanced interactions and convenient accessibility, enable this learning platform to provide users with hands-on self-directed learning experiences. For example, users can collaborate on activities in virtual environments from multiple platforms with only one link. In addition, the Spatial.io supports a wide range of devices and can be easily accessed via a web browser without no need for any additional software installation. All of these were the key features chosen for developing the educational platform in this study. Primarily, this study involved the design of virtual learning environments and classrooms, including the tools needed to study the course content.

The researchers also integrated metaverse technology in this development with the intention of helping learners practice useful skills and knowledge while dealing with hands-on experiences.

The EDTL Platform with Metaverse consists of five virtual classrooms as follows:

(1) Smart Classroom, which is the learning space facilitated via metaverse;

(2) Smart Library, which is also a learning space provided for the students who want to search for additional knowledge or expand their learning beyond the given lesson contents;

(3) Project Classroom, which refers to a classroom for displaying projects or pieces of work;

(4) Design Room, which is a metaverse classroom intended for holding virtual meetings for the students to work on their projects; and

(5) Meeting Room, which refers to a classroom in metaverse environment designated for the students to present their projects or assignments to the instructor.

The classrooms on the EDTL Platform with Metaverse are illustrated in Figure 2.

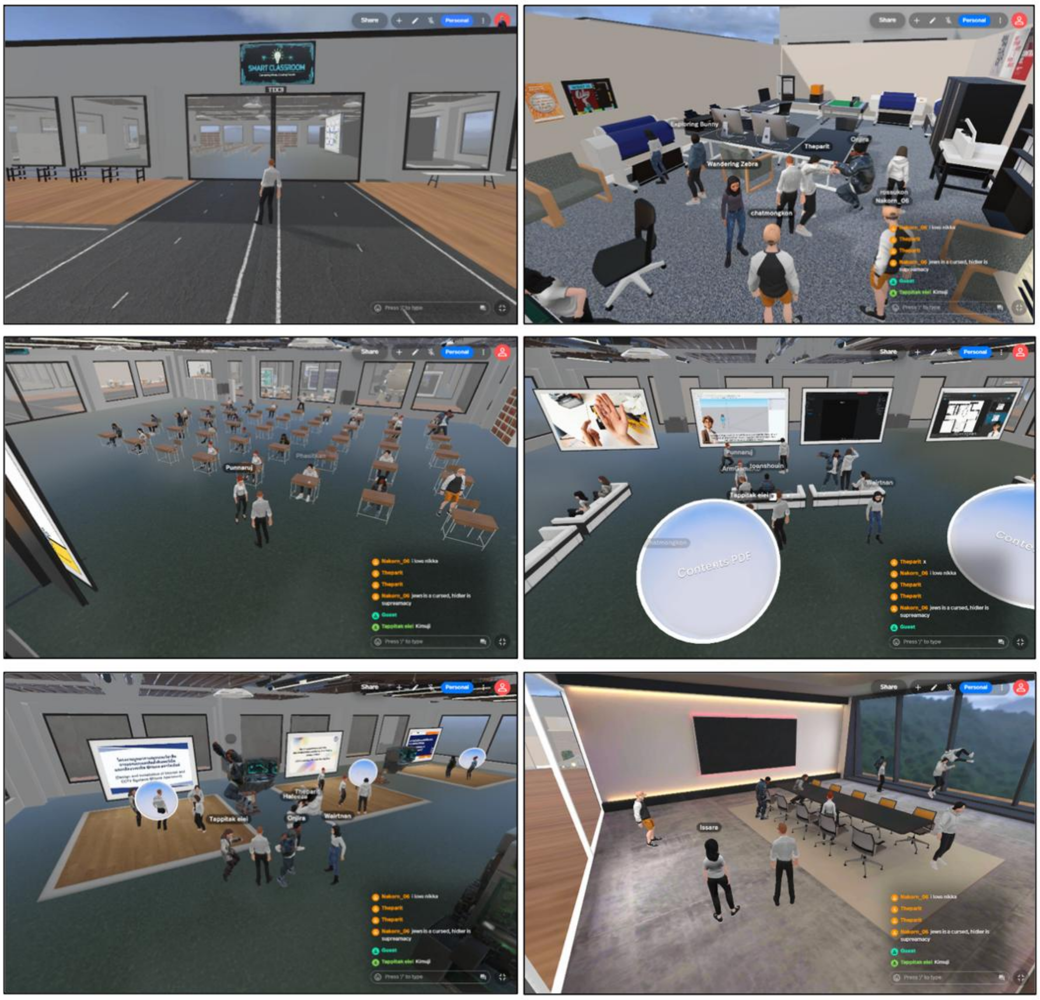

Figure 2: EDTL Platform with Metaverse

4.3 Phase 3: Findings After Learning with the EDTL Platform with Metaverse

The researchers carried out the study on the overall results after having the research participants use this platform, which was based on the five research hypotheses. The outcomes of this phase were concluded as follows:

4.1.1 Evaluation of the Quality of the EDTL Platform

The study on the quality of the EDTL Platform was conducted by means of a questionnaire. The assessment was divided into four aspects (content, design, efficiency, and practical use) and comprised 26 items of evaluation in order to test RH1. The detailed results of the evaluation are presented in Figure 3.

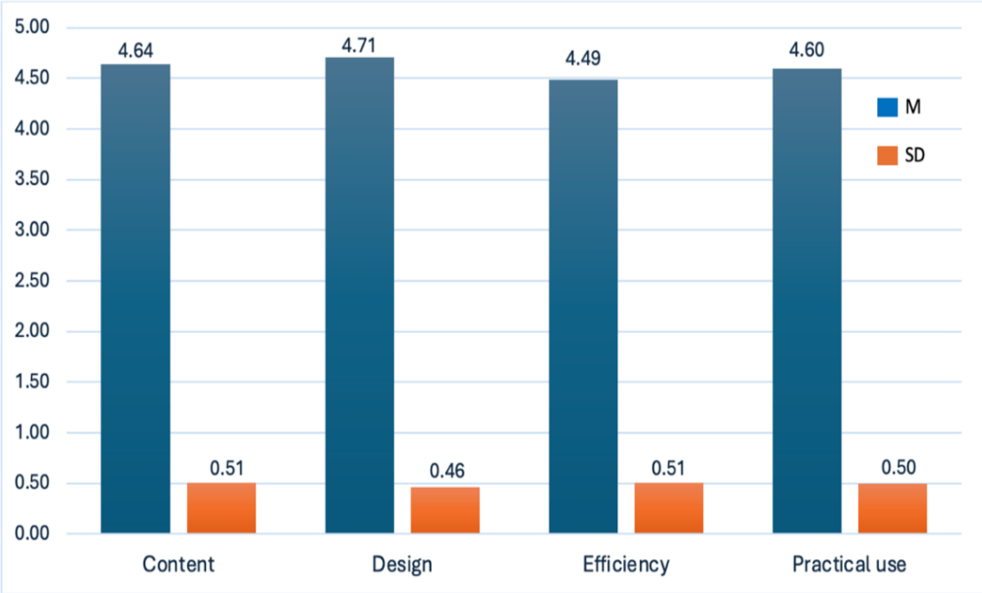

Figure 3: Quality of the platform by the experts

Figure 3 shows the overall quality of the said platform. Taking into account each aspect separately, the quality of content is at a high level (M = 4.64, SD = 0.51); design is at a high level (M = 4.71, SD = 0.46); efficiency was at a high level (M = 4.49, SD = 0.51); and practical use (M = 4.60, SD = 0.50) was at a high level. It can be clearly seen that the aforementioned results are consistent with the RH1. Furthermore, the research results reaffirmed that the EDTL Platform with Metaverse is an effective and practical learning tool that can help to develop teamwork skills and problem-solving skills. The platform supports authentic workplace learning by integrating practical learning experiences, learning content and digital learning tools within a metaverse environment.

All these are believed to offer learning activities that can promote self-learning. This is in line with the research of Tasen et al. (2024), which found that experiential learning combined with design thinking promotes self-directed learning and develops learners' creativity and product development skills through practical experience and the application of innovative solutions. In addition, this style of learning can appropriately fulfil the needs of learners in the digital age since it enables them to achieve continuous and customized learning, which will further enhance their experience and lead to more valuable achievements.

4.1.2 Comparison of Learning Achievement Scores

The comparative study of learning achievement scores was performed using the pre-test and post-test that consist of 30 multiple-choice questions (four options). The study was conducted twice with the single sample group so as to test RH2. The results are shown in Table 2.

Table 2: Comparison of learning achievement scores (n=30; full score = 30)

Test	M	SD	ΔM	ΔSD	95% CI for ΔM	*t*(df)	*p*
Pre-test	10.30	3.13	16.00	1.01	[15.62, 16.38]	24.60 (29)	< *0.01*
Post-test	26.30	2.12					

Note. ΔM = mean difference; ΔSD = SD of difference

Table 2 and Figure 4 show that students' mean learning achievement score increased from 10.30 (SD = 3.13) before using the platform to 26.30 (SD = 2.12) after using it, indicating improved learning achievement. The findings show that the platform can significantly improve the students' learning achievement with the statistical significance level at .01, which is clearly consistent with RH2. The preliminary results confirmed that the platform had a high potential for further practical application because it encouraged students to become more engaged in learning activities and helped them understand the lessons better.

Doing the post-tests immediately after studying the lesson content also contributed to higher learning achievement of these students. In addition, the outcomes align with the research of Fioravanti et al. (2023), who found that experiential learning approaches can offer hands-on experiences that resemble those found in the software industry. The findings also showed significant improvements in communication and teamwork skills after students used the platform. Furthermore, there were improvements in leadership, adaptability and resilience as learners thought the obtained experiences were useful and engaging for their learning.

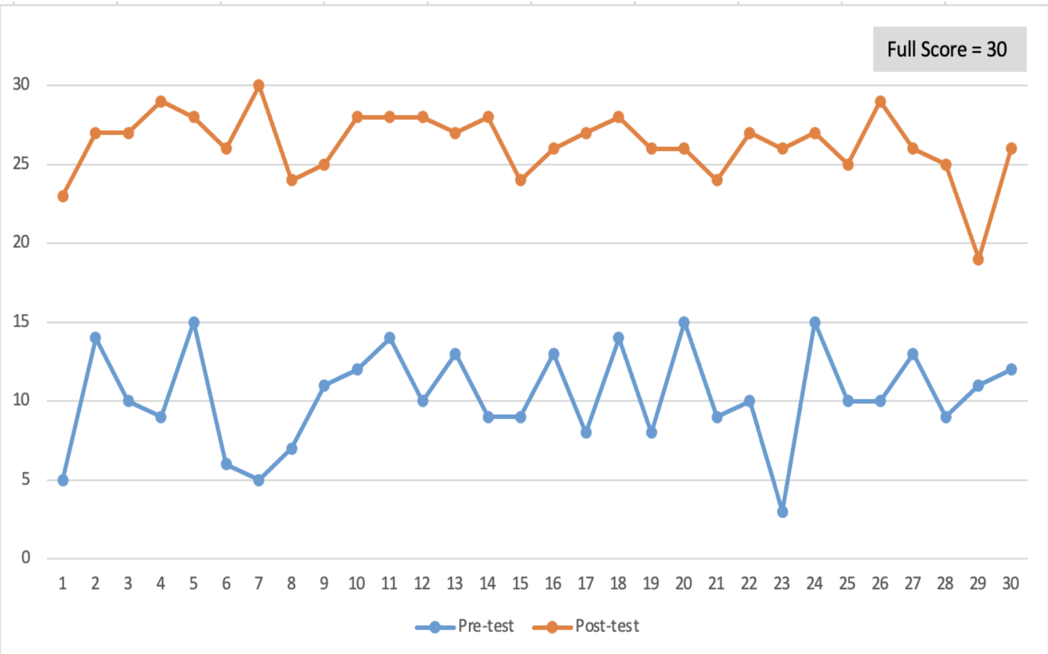

Figure 4: Learning achievement of individual students before and after learning

The outcomes of learning achievement in Figure 4, both before and after using this platform, clearly reflect each student's effectiveness in learning. Individual student scores were significantly higher after using the EDTL Platform with Metaverse than before, indicating that the platform improved learning achievement. The results are consistent with the findings of Che (2026) that design thinking (DT) can be used as a structured, evidence-based learning approach in order to drive more innovations in higher education institutions. Furthermore, DT can promote greater engagement in learning, which is believed to result in better learning outcomes.

4.1.3 Evaluation of Teamwork Skills

Teamwork skills were assessed by the instructor using the 4-level rating scale for authentic assessment (as shown in Table 3) and four learning activities in order to test the research hypothesis 3 (RH3). The activities included (Activity 1) network system design and troubleshooting; (Activity 2) network design and installation; (Activity 3) network system design and configuration; and (Activity 4) network system design and simulation of an organizational network installation.

The criteria and interpretations of teamwork skills are shown below:
- A score of 13.00 - 15.00 means the teamwork skills are at a very good level.
- A score of 8.00 - 12.99 means the teamwork skills are at a good level.
- A score of 3.00 - 7.99 means the teamwork skills are at a moderate level.
- A score of 0.00 - 2.99 means the teamwork skills need improvement.

Table 3: Results of evaluation on teamwork skills (total score=15, n=30)

Learning activity	M	Mean score	Results
Activity 1	13.33	13.59	Very good
Activity 2	13.07		
Activity 3	14.07		
Activity 4	13.87		

Table 3 explains the results of the authentic assessment on teamwork skills of the students who used the learning platform. The average score indicates that the students' teamwork skills were at a very good level (Mean average = 13.59). Likewise, in considering the score found for each of the four learning activities, the teamwork skills were at a very good level. This empirical evidence indicates that engagement is a key mechanism to enhance teamwork skills in vocational education systems, particularly those that are developed within the metaverse.

In an era of rapidly changing technologies, the ability to integrate various modern technologies in learning management can also enhance learning effectiveness. The above results are not only in accordance with the RH3, but also in line with the research of Klinmalee (2022), who found that the facilitation of cooperative activities in online learning enables learners to develop both planning skills and teamwork skills. It is also believed that the instruction management of this kind will improve learners' enthusiasm for learning in the long run.

4.1.4 Evaluation of Problem-solving Skills

The problem-solving skills were measured by means of the 4-level rating scale for authentic assessment (as shown in Table 4) as well as four learning activities to test RH4. The criteria and interpretations of problem-solving skills are as below:

- A mean score of 13.00 - 15.00 refers to very good level.
- A mean score of 8.00 - 12.99 refers to good level.
- A mean score of 3.00 - 7.99 refers to moderate level.
- A mean score of 0.00 - 2.99 refers to need improvement level.

Table 4: Results of evaluation on problem-solving skills (total score=15, n=30)

Learning activity	M	Mean score	Results
Activity 1	12.83	13.50	Very good
Activity 2	13.23		
Activity 3	13.90		
Activity 4	14.03		

The results of the authentic assessment on the students' problem-solving skills after using the platform confirm that their problem-solving skills were at very good level (Mean average = 13.50). In addition, the score for the skills in each of the four learning activities was at a very good level that the findings relate to RH4. It can be clearly seen from these research findings that the active engagement in hands-on learning is a key mechanism to develop problem-solving skills.

Moreover, being faced with real-world situations and problems through the metaverse helps learners refine their analytical thinking skills, make decisions in a more systematic manner, and find other approaches to solve problems. The findings are also consistent with those of Sangwan and Singh (2022), who found that experiential learning enhances engineering graduates' problem-solving skills by strengthening critical thinking and promoting innovative approaches to solving problems. All these are considered crucial skills for future careers that can satisfy the demands of the labor market.

4.1.5 Satisfaction after learning with the platform

This section involves the evaluation on the students' satisfaction with the EDTL Platform with Metaverse after learning with it. The evaluation form contained 20 questions covering all four aspects of the platform, i.e., content, design, efficiency, and application for practical use. The researchers relied on descriptive statistics which can describe or summarize the characteristics of the data found in the findings without making any generalizations to other groups. The findings of this study may inform future research in this field. The evaluation was conducted to examine the RH5. The results are presented in Table 5.

Table 5: Results of evaluation on satisfaction

Aspects of satisfaction/items		**M**	**SD**
Content	The explanations about contents are explicit	4.73	0.44
	The objectives are clearly stated and aligned with the course contents	4.67	0.47
	The arrangements of contents are easy to understand	4.63	0.55
	The contents are appropriate for learners	4.80	0.40
	The contents are up to date	4.70	0.46
Design	The presentation is attractive and engaging	4.80	0.40
	The illustrations are clear and relevant to the contents	4.73	0.44
	The teaching materials are interesting and correspond to the contents	4.70	0.46
	The font sizes are appropriate, easy to read, and clear	4.77	0.42
	Learners are able to exchange knowledge with others in the group through this platform	4.77	0.42
Efficiency	The EDTL Platform with Metaverse is stable and fast	4.67	0.47
	The EDTL Platform with Metaverse can promote self-directed learning	4.70	0.46
	The EDTL Platform with Metaverse can be accessed easily anywhere and anytime	4.87	0.34
	The EDTL Platform with Metaverse is aligned with today's modern learning	4.73	0.44
	The EDTL Platform with Metaverse is suitable for use as a supplementary learning tool	4.67	0.47
Practical use	Learners can enhance their learning outcomes through this platform	4.67	0.47
	Learners can understand the lesson contents that match with their learning competency	4.77	0.42
	Learners require the learning model of this type for other subjects	4.70	0.46
	Learners have gained improved teamwork skills	4.90	0.30
	Learners have gained enhanced problem-solving skills	4.80	0.40
Average		4.74	0.44

The findings shown in Table 5 indicate that the overall satisfaction with the EDTL Platform with Metaverse was at a high level (M = 4.74, SD = 0.44). The findings confirm RH5 and are consistent with the research of Tasen et al. (2024), who found that experiential learning with DT can develop innovative competency among learners, which can further help them to improve as creative innovation designers. It is also expected that this approach will increase learners' motivation and positive attitudes towards learning, encouraging them to develop innovative ideas and solutions. Virtual learning environments that support practical application can increase learners' interest in experiential learning, enable self-paced knowledge acquisition, enhance engagement with learning content and improve learning satisfaction.

5. Conclusion

The EDTL Platform with Metaverse is a learning tool designed primarily to enhance learners' teamwork skills and problem-solving skills. The learning platform was developed by integrating experiential learning, design thinking and metaverse technology to support self-directed learning and provide vocational students with flexible access to learning content, digital tools and authentic learning experiences anytime and anywhere. This study evaluated stakeholders' perspectives on the platform and assessed its quality and practicality in promoting learners' teamwork and problem-solving skills. Furthermore, participants reported that the platform provided a reliable experiential learning and design thinking process within a metaverse environment, supported by a systematic synthesis of relevant literature. They also indicated that the interactive virtual environment and collaborative activities increased learners' interest, engagement and sustained participation in learning.

To summarize, this research paper can be used as a guideline for further studying the development of an EDTL Platform with Metaverse, which is designed specifically to enhance learners' experiences by means of experiential learning combined with DT. The said platform can also increase learning flexibility as it can be accessed via a variety of gadgets, devices, and smartphones anywhere and anytime. The platform also makes teaching and learning more engaging by using digital technologies to create immersive virtual learning environments, offering valuable opportunities for vocational education in Thailand.

6. Research Implications and Contribution

This study demonstrates that a learning platform integrating experiential learning, design thinking and metaverse technology can improve vocational students' learning achievement, teamwork and problem-solving skills while increasing learner engagement and satisfaction. Building on previous research and the EDTL Model with Metaverse, the study developed and evaluated a practical learning platform for vocational education. The findings suggest that the platform can support technology-enhanced teaching and learning and provide a useful framework for modernizing curricula and instructional practices to meet the evolving needs of the labour market. It also contributes to preparing students with the knowledge, skills and attitudes required for future employment.

7. Limitations and Future Research

This study has several limitations that have important theoretical and methodological implications. A limitation of the study was the small sample size, which limited the diversity of participants' knowledge, skills and collaborative learning experiences. Therefore, the researchers suggest the following guidelines for future research.

First of all, a future study should be conducted with larger sample sizes pf people who have diverse educational backgrounds in order to increase the accuracy of research conclusions. Future research could be done with a larger sample size and more diverse participants, for instance, students from different institutions, other academic programs, and other regions, so as to ensure that the research findings are more widely applicable. Secondly, it was insufficient to have only one instructor as an evaluator in this study because there could be some bias from the said instructor. Therefore, future studies should have more than one evaluator who must be subjected to certain assessments in order to verify their credibility.

Next, a comparative study on the EDTL Platform with Metaverse and traditional learning, using more robust research methods, such as control group or quasi-experimental design could improve the validity of the conclusions from the empirical study. Future research could use mixed methods, including interviews, focus groups and analysis of users' activities in the metaverse, to gain a deeper understanding of students' learning experiences. The influences of each learning format, such as experiential learning, DT, and learning through the metaverse, could be analyzed separately to determine which factor has most influence on the improvement of learning outcomes.

It is also recommended that longitudinal research be conducted to determine whether the platform has a sustainable impact on the development of 21st century skills or not. Such research could strengthen the evidence base and practical application of this approach, support its wider implementation and contribute to improvements in education.

Conflict of Interest

Authors state no conflict of interest.

8. Author Contributions

Mr. Sukan Saeliang contributes to creating research ideas, original draft, and analyzing the data; Dr. Pinanta Chatwattana coordinate the submission of the manuscript, developing the research methodology, revised and compose the writing quality of the manuscript; and Dr. Pallop Piriyasurawong developing the research methodology and validation the data.

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Appendix

The assessment form on the quality of the EDTL Platform with Metaverse

No.	Items
1	**Quality of Content:** 1.1 The learning objectives are clearly defined. 1.2 The contents are in compliance with the learning objectives. 1.3 The contents are provided in appropriate sequences. 1.4 The structure of contents is clear and coherent in itself. 1.5 The size of contents is appropriate. 1.6 The language used is correct and covers all the course contents. 1.7 The examples given are relevant to the contents. 1.8 There are exercises and assessments that cover all the learning objectives comprehensively. 1.9 The contents are up to date. 1.10 The overall contents are suitable and can promote teamwork skills of learners. 1.11 The overall contents are appropriate and can promote problem-solving skills of learners.
2	**Quality of Design:** 2.1 The platform design is attractive. 2.2 The platform design is appropriate and corresponds to the contents. 2.3 The overall layout of the platform is appropriate. 2.4 The font sizes used within the platform are appropriate. 2.5 The lessons within the platform are interesting.
3	**Efficiency:** 3.1 The EDTL Platform with Metaverse is easy to use. 3.2 The EDTL Platform with Metaverse contains sufficient functions for learning. 3.3 All functions in the EDTL Platform with Metaverse are complete. 3.4 The EDTL Platform with Metaverse provides accurate responses. 3.5 The EDTL Platform with Metaverse provides quick responses with continuity.
4	**Quality of Practical Use:** 4.1 The platform is stable and efficient. 4.2 The platform can be accessed anywhere and anytime. 4.3 The platform is flexible and adaptable to users' needs. 4.4 The platform is compatible with a wide range of devices and operating systems. 4.5 The platform can be put to practical use to foster teamwork skills and problem-solving skills.