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Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration

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Abstract

The Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration. The concept is based on the integration of hybrid learning, project-based learning, and metaverse. This research has the objective: (1) To study and synthesize the conceptual framework of the hybrid project-based learning model on metaverse to enhance collaboration. (2) To develop the hybrid project-based learning model on metaverse to enhance collaboration. (3) To study the suitability of the hybrid project-based learning model on metaverse to enhance collaboration. Research hypothesis: The suitability of the hybrid project-based learning model on metaverse to enhance collaboration is at the high level. The participants in this research include seven experts from various institutions, all of whom are specialized in the design and development of instruction models and systems. The results, show that (1) This research can serve as a guideline for developing a hybrid project-based learning via metaverse that can enhance collaboration, consisting of a 6-step hybrid project-based learning process, integrated with metaverse. (2) the overall suitability of the development to the hybrid project-based learning model on metaverse to enhance collaboration is at a very high level (Mean = 4.92, S.D. = 0.18, IR = 0.04, Q.D. = 0.02), (3) The results of the evaluation certify the suitability of using the hybrid project-based learning model on metaverse to enhance collaboration is suitable for actual use at a very high level (Mean = 4.71, S.D. = 0.76, IR = 0.00, Q.D. = 0.00).

Keywords: hybrid project-based learning, hybrid learning, project-based learning, metaverse, collaboration

1. Introduction

The rapid evolution of technology, both in hardware and software, is prompting educational systems to adapt. It's crucial to equip learners with foundational skills and problem-solving abilities to thrive in the 21st century. Integrating technology into education is key for skill development and fostering innovation. These changes are driving movements toward Industry 4.0, enhancing productivity and economic value. Educational curricula are being tailored to produce competent individuals for the workforce and to support the country's science and technology advancement. Learners are encouraged to cultivate creativity and additional skills for future career success (Khunpolkaew, 2021; Secretariat Office of the Teachers' Council of Thailand, 2020; Sophonpanich, 2022).

Hybrid Learning refers to the integration of traditional classroom settings with technology, such as computers and the internet, allowing learners to access learning materials anytime, anywhere. This format helps bridge the technology gap and provides opportunities for both synchronous and asynchronous learning through online networks (Tangjitnusorn & Sukavatee, 2016). It enables interaction between instructors and peers as desired, while also offering flexibility in time and location for learning. This approach is increasingly popular in modern times and can foster creativity among learners through the utilization of technology and networking systems (Srisawatchim, 2011).

Project-Based Learning is a learning method that emphasizes acquiring skills necessary for life in the 21st century by providing learners with opportunities to solve problems and address societal needs through accessible and effective projects. In this learning approach, instructors serve not only as "Instructors" but also as facilitators of learning, enabling learners to learn autonomously and develop creative thinking. This learning experience

deepens learners' understanding and awareness of knowledge, focusing on solving real-world problems directly within the society. It promotes teamwork skills and creative problem-solving abilities (Thonghaew and Chaijaroen, 2020).

Metaverse is a virtual environment created by computer technology to provide users with experiences closely resembling real-life experiences. It originally emerged primarily in gaming but has features that enable users to engage in group interactions (Raviwongse, 2022). In the Metaverse, users have spaces to chat, exchange ideas, and participate in various activities such as gaming, meetings, and concerts. Users can interact with each other both by appointment and spontaneously, leading to encounters with new groups of people and creating new forms of social interaction (Wuthisen 2023).

Collaboration is a vital skill in the 21st century, particularly in learning and innovation, as it influences knowledge application. Interactions among peers, instructors, and the learning environment facilitate the development of analytical, synthetic, evaluative, and creative skills. Teamwork fosters idea exchange and communication skill development, making collaborative learning more effective than individual work. Emphasizing collaboration in learning management is crucial for personal and future success (Jarusawat, 2020; Juithong, 2018).

From all the above make important developing and designing the Hybrid Project-Based Learning on the Metaverse is a novel approach that leverages technology to promote collaboration and creative thinking in education. This platform integrates project-based learning into the Metaverse, creating immersive learning experiences that cater to the demands of the 21st century. By emphasizing innovation and collaboration, it equips learners with the skills needed to thrive in the digital era and meet the needs of evolving industries. Ultimately, this platform enhances learners' confidence and capabilities, positioning them for success in the future.

2. Research Objectives and Hypothesis

2.1 Research Objectives

1) To study and synthesize the conceptual framework of the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration.
2) To develop the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration.
3) To study the suitability of the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration.

2.2 Research Hypothesis

The suitability of the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration is at the high level which is Mean ($\bar{x}$) more than 4.51 scores.

3. Methodology

This research is related to the design and the development of the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration, and the research methodology includes the following:

3.1 Research Participants

Seven experts from various institutions which specializes in designing and developing teaching models, teaching systems, or learning technologies.

3.2 Research Tools and Statistics used for Data Analysis.

To Develop the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration, the researchers employed the following research tools, i.e.

1) The Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration.
2) The evaluation form on the suitability of the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration. Statistics used for data analysis include Mean (average), Standard Deviation (S.D.), Inter-Quartile Range (IQR), and Quartile Deviation (Q.D.).

3.3 Research Methodology

Phase 1: Studies and analyzed the conceptual framework of the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration. In this phase, the researcher studied, researched, analyzed, and synthesized documents, data, and literature related to (1) Project-Based Learning, (2) Hybrid Learning, (3) Metaverse, and (4) Collaboration as seen in Figure 1.

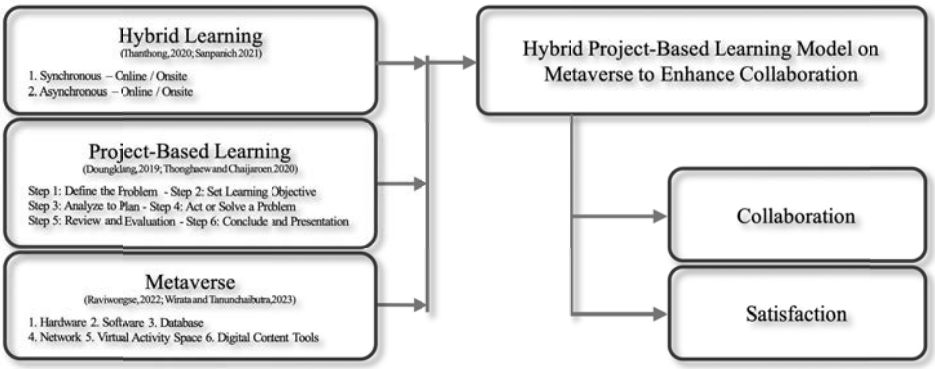

Figure 1. Conceptual framework

After defining the concept, the researcher has studied and reviewed articles and research related to the elements of the learning model by focusing on 4 topics which are (1) Project-Based Learning Process. (2) Hybrid Learning Elements (3) Metaverse Elements, and (4) Collaboration Components. Detailed as follows:

1) Project-Based Learning: is a method that helps develop students' learning skills, allowing them to build knowledge by themselves through hands-on practice based on their interests. Instructors stimulating students to study, research, and engage in practical activities. This process consists of 6 steps: 1. Define the problem 2. Set learning objectives 3. Plan and analyze the problem 4. Act or solve the problem 5. Evaluate 6. Summarize (Doungklang, 2019).

2) Hybrid Learning: is a teaching and learning management system that integrates the benefits of synchronous (face-to-face) learning and asynchronous (online learning) effectively. It blends various teaching and management techniques to create a cohesive learning experience (Bamrungsetthapong et al., 2020).

3) Metaverse: the Metaverse, or virtual reality technology, is predicted to be a major turning point on the Internet of Things industry. It is an environment created and processed by computer technology to provide users with experiences closely resembling real-life experiences (Raviwongse, 2022).

4) Collaboration: There are five components and factors of teamwork skills for undergraduate students, as follows: Component 1: Task performance skills, Component 2: Interpersonal skills, Component 3: Communication skills, and Component 4: Listening and summarizing skills (Wimut & Topithak, 2022).

Phase 2: Studies and synthesized of the components of the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration. In this phase, the researchers studied and synthesized the components of the Hybrid Project-Based Learning Model on Metaverse as follows: (1) Project-Based Learning, (2) Hybrid Learning, (3) Hybrid Project-Based Learning, (4) Metaverse, and (5) Hybrid Project-Based Learning with Metaverse. The researchers designed assessment tools based on the components of Collaboration. They studied, researched, analyzed, and synthesized research related to this, finding five components, as seen in Table 1-5.

Table 1. Project-based learning process synthesis table

"Project-Based Learning Process" Literature Synthesis	Description		Morah (2018)	Seesukong & Pitak (2018)	Spikol et al. (2018)	Doungklang (2019)	Ji & Chayanuvat (2020)	Kiatphotha & Niyomsap (2020)	Supatchayabhumi, Yoelao, & Jinnge (2020)	Thonghaew & Chaijaroen (2020)	Songkru, Nacnaprasiu, & Pratoomtong (2021)	Thet Aung & Tang (2021)
	Instructor	Learner										
Step 1: Define the Problem	Define and define a problem or project.	Use the thought process and explore interests to define.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Step 2: Set Learning Objective	Set goals or objectives for learners.	Know the purpose and destination of learning.	-	-	-	✓	✓	-	-	✓	✓	✓
Step 3: Analyze to Plan	Recommend an action plan based on the characteristics.	Analyze and plan operations.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Step 4: Act or Solve a Problem	Facilitate learning efficiency.	Learn to solve problems using hands-on methods to develop various skills.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Step 5: Review and Evaluation	Provide opportunities for learners to express their evaluations of what they have learned.	Evaluate the results of operations or solutions to problems obtained.	✓	✓	-	✓	✓	✓	-	-	✓	✓
Step 6: Conclude and Presentation	Evaluate results from having students summarize. Presentation and discussion.	Summarize results and present all learnings. Discussion for further development.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

From Table 1, the researcher concludes the Project-Based Learning Process synthesis table and summarizes the six steps of the project-based learning process as follows:

Step 1: Define the Problem: Teachers introduce the problem or set contexts for learning, encouraging students to explore their interests and define their own context.

Step 2: Set Learning Objectives: Instructors establish learning goals, providing essential project information and demonstrating management methods to clarify the purpose and destination of learning.

Step 3: Analyze to Plan: Students create schedules for project execution, emphasizing thorough planning based on the given problem or goal.

Step 4: Act or Solve a Problem: Students engage in practical implementation or problem-solving, monitored by the teacher to prevent common issues in group work and facilitate efficient learning.

Step 5: Review and Evaluation: Students assess their actions and problem-solving methods, fostering critical thinking and providing an opportunity for assessment.

Step 6: Conclude and Presentation: Students summarize learning outcomes and engage in discussions to further develop acquired knowledge or skills, emphasizing comprehensive assessment of learning performance and collaborative problem-solving.

Table 2. Hybrid learning elements synthesis table

"Hybrid Learning Elements" Literature Synthesis	Bamrungsetthapong, Tharnpanya, & Satiaharuthai (2020)	Thanthong (2020)	Athonvarangkul, Dibyamadala, & Mangkhang (2021)	Benzene (2021)	Sanpanich (2021)	Kongsumruay, Nedpakdee, & Srito (2021)	Sisamud, Wannapiroon, & Palee (2022)
1. Synchronous/Asynchronous							
1.1 Onsite	✓	✓	✓	✓	✓	✓	✓
1.2 Online	✓	✓	✓	✓	✓	✓	✓
2 Live-Streaming/Classroom	✓	✓	✓	✓	✓	✓	✓
3. Learning Management System/e-Learning	✓	✓	✓	✓	✓	✓	✓
4. Courseware/Interactive Content	✓	✓	-	✓	✓	✓	-
5. Cloud Technology/Digital Media Tools	✓	✓	✓	-	✓	✓	✓
6. Online Examination/Test System	✓	✓	✓	✓	-	✓	-

From Table 2, the researcher concludes the Hybrid Learning Elements synthesis table and summarizes that the elements of hybrid learning consist of six main components as follows:

1) Synchronous/Asynchronous: Includes both onsite and online formats to accommodate real-time communication and access to learning materials at different times from anywhere.

2) Live-Streaming/Classroom: Provides options for instructors to conduct teaching and learning sessions either online through live-streaming tools or in physical classroom settings.

3) Learning Management System/e-Learning: Utilized for managing students, lesson content, and various aspects of learning, typically through specialized software.

4) Courseware/Interactive Content: Supplementary teaching materials or interactive learning media designed to enhance effective learning.

5) Cloud Technology/Digital Media Tools: Digital tools and cloud-based technologies integrated into the learning system to facilitate efficient teaching and learning processes.

6) Online Examination/Test System: Crucial for assessing and measuring student learning outcomes comprehensively and evaluating teaching effectiveness and through online examination or testing systems.

Table 3. Project-based learning process with hybrid learning elements synthesis table

Project-Based Learning	Hybrid Learning				Learning Element					
	Synchronous		Asynchronous							
	Onsite	Online	Onsite	Online	Classroom	Live-Streaming	LMS	Courseware	Digital Media Tools	Online Examination
Step 1: Define the Problem	✓	✓	-	-	✓	✓	✓	✓	-	✓
Step 2: Set Learning Objective	✓	✓	✓	✓	✓	✓	✓	✓	-	-
Step 3: Analyze to Plan	✓	✓	✓	✓	✓	✓	✓	✓	✓	-
Step 4: Act or Solve a Problem	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Step 5: Review and Evaluation	✓	✓	✓	✓	✓	✓	✓	-	✓	-
Step 6: Conclude and Presentation	✓	✓	-	-	✓	✓	✓	-	✓	✓

From Table 3, the researcher concludes the Project-Based Learning Process with Hybrid Learning Elements synthesis table and summarizes that consists of various learning elements as follows:

Step 1: Define the Problem. This step focuses on synchronous learning, both in onsite and online formats, as it requires direct interaction between instructors and students to define and clarify problems. It incorporates classroom and live-streaming teaching methods, along with the use of Learning Management System (LMS) and courseware to enhance understanding of problem definitions or project scopes. Online examination is also utilized to assess students' fundamental knowledge.

Step 2: Set Learning Objectives. Learning can occur synchronously and asynchronously, onsite and online, as instructors can provide essential learning information, research materials, and learning objectives aligned with the course content. Classroom and live-streaming teaching methods, along with the use of LMS and courseware, are employed to establish learning goals and engage students.

Step 3: Analyze to Plan. This step allows for synchronous and asynchronous learning, onsite and online, involving analysis and planning of project timelines. Instructors guide students in preparing plans based on received problem statements or objectives. The analysis involves considering various components and utilizing classroom and live-streaming teaching methods, LMS, courseware, and digital media tools to facilitate effective planning.

Step 4: Act or Solve a Problem. Learning can occur synchronously and asynchronously, onsite and online, as students undertake practical activities or problem-solving tasks. Instructors facilitate learning by ensuring efficiency through various learning elements, including classroom and live-streaming teaching methods, LMS, courseware, and other necessary tools, fostering skill development.

Step 5: Review and Evaluation. This step allows for synchronous and asynchronous learning, onsite and online, as instructors evaluate students' performance or problem-solving approaches. It encourages students to engage in self-assessment and critical thinking through result review and progress demonstration. Various learning elements, including classroom and live-streaming teaching methods, LMS, and digital media tools, enable effective self-review and evaluation.

Step 6: Conclude and Presentation. This step emphasizes synchronous learning in onsite and online formats, as instructors directly interact with students to summarize learning outcomes and deliver presentations. It involves summarizing all learning outcomes, presenting findings, and discussing ways to further enhance knowledge or skills. Learning elements include classroom and live-streaming teaching methods, LMS, and digital media tools to ensure comprehensive learning and collaboration, culminating in online examination to test acquired knowledge.

Table 4. Metaverse elements synthesis table

"Metaverse Elements" Literture Synthesis	Raviwongse (2022)	Tanunchaibutra (2023)	Hongphanut (2023)	Kantaboon (2022)	Boonlue (2022)	Areepong, Nilsook, & Wannapiroon (2022)	Khanitthabud & Lakkhongkha (2023)	Wuthisen (2023)
Hardware	✓	✓	✓	✓	✓	✓	✓	✓
Software	✓	✓	✓	✓	✓	✓	-	✓
Database	✓	✓	✓	✓	✓	-	✓	✓
Network	✓	✓	✓	✓	✓	✓	-	-
Virtual Activity Space	✓	✓	✓	✓	-	✓	-	-
Digital Content Tools	✓	✓	✓	✓	-	✓	✓	-

From Table 4, the researcher concludes the Metaverse Elements synthesis table and summarizes that the elements of the metaverse consist of key components as follows:

1) Hardware: Devices like VR headsets and smartphones enable immersive experiences in virtual worlds by processing simulations of realistic environments.

2) Software: Programs and apps utilize algorithms to create and process virtual environments, enhancing sensory perceptions such as sight and sound.

3) Database: Stores data related to various metaverse components like avatars, resources, and locations, utilizing external systems for diverse file types.

4) Network: Supports internet connectivity and data transmission, crucial for operating virtual reality devices and accessing metaverse content.

5) Virtual Activity Space: Simulates different scenarios for activities like learning or collaboration, offering spaces for brainstorming, presentations, or exhibitions.

6) Digital Content Tools: Facilitate content creation and management for activities in the virtual world, enabling interaction and maximizing metaverse benefits.

Table 5. Hybrid project-based learning with metaverse elements synthesis table

Project-Based Learning	Hybrid Learning				Learning Element via Metaverse						
	Synchronous		Asynchronous		Database/Network						
					Hardware/Software/Digital Content Tools						
	Onsite	Online	Onsite	Online	Classroom	Live-Streaming	LMS	Courseware	Digital Media Tools	Online Examination	Virtual Activity Space
Step 1: Define the Problem	✓	✓	-	-	✓	✓	✓	✓	-	✓	Brainstorming Space
Step 2: Set Learning Objective	✓	✓	✓	✓	✓	✓	✓	✓	-	-	Self-Paced Learning Space
Step 3: Analyze to Plan	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	Brainstorming Space
Step 4: Act or Solve a Problem	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Self-Paced Learning Space
Step 5: Review and Evaluation	✓	✓	✓	✓	✓	✓	✓	-	✓	-	Exhibition Space
Step 6: Conclude and Presentation	✓	✓	-	-	✓	✓	✓	-	✓	✓	Presentation Space

From Table 5, the researcher concludes the Hybrid Project-Based Learning with Metaverse Elements synthesis table and summarizes that hybrid project-based learning with metaverse elements consist of key components as follows:

Step 1: Define the Problem - This step emphasizes synchronous learning in both onsite and online formats to

interact directly with students and define project problems. It incorporates classroom teaching, live-streaming sessions, Learning Management Systems (LMS), and courseware to enhance understanding and assess students' fundamental knowledge through online examinations. The Virtual Activity Space is utilized as a Brainstorming Space to promote this step.

Step 2: Set Learning Objectives - Learning objectives can be achieved synchronously and asynchronously, onsite and online, as instructors provide essential learning information, research materials, and objectives aligned with course content. Classroom teaching, live-streaming sessions, LMS, and courseware are employed to establish learning goals and engage students. The Virtual Activity Space serves as a Self-Paced Learning Space in this step.

Step 3: Analyze to Plan - This step allows for both synchronous and asynchronous learning, onsite and online, involving the analysis and planning of project timelines. Instructors guide students in preparing plans based on received problem statements or objectives. Classroom teaching, live-streaming sessions, LMS, courseware, and digital media tools are utilized to facilitate effective planning. The Virtual Activity Space functions as a Brainstorming Space.

Step 4: Act or Solve a Problem - Learning can occur synchronously and asynchronously, onsite and online, as students undertake practical activities or problem-solving tasks. Instructors facilitate learning by ensuring efficiency through various learning elements, fostering skill development. The Virtual Activity Space is utilized as a Self-Paced Learning Space in this step.

Step 5: Review and Evaluation - Evaluation can occur synchronously and asynchronously, onsite and online, as instructors assess students' performance or problem-solving approaches. It encourages self-assessment and critical thinking through result review and progress demonstration. Various learning elements enable effective self-review and evaluation. The Virtual Activity Space functions as an Exhibition Space in this step.

Step 6: Conclude and Presentation - This step emphasizes synchronous learning in both onsite and online formats, as instructors directly interact with students to summarize learning outcomes and deliver presentations. It involves summarizing all learning outcomes, presenting findings, and discussing ways to further enhance knowledge or skills. Various learning elements ensure comprehensive learning and collaboration, culminating in online examinations to test acquired knowledge. The Virtual Activity Space serves as a Presentation Space in this step.

Phase 3: Designing and developing the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration to further evaluate suitability. In this phase, the researchers studies and took the synthesized result components from Tables 1-5 to design the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration. And evaluate the suitability of the model by 7 education experts derived by means of purposive sampling with the research evaluation form tool. These participants come from various institutions and all of them are experts specialized in the design and development of learning models and learning technologies.

Phase 4 Studies the suitable result of the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration. In this phase, the researchers used study the suitability results after this model had been evaluated by seven experts from previous phase. Then analized the results by mean score range, standard deviation, quartile range and inter-quartile range of results are listed in Table 6. The definition of consensus in key studies as follows.

Table 6. The definition of consensus in key studies

Statistics	Definition of Consensus	Reference
Mean		
4.50 – 5.00	Strong agree	
3.50 – 4.49	agree	
2.50 – 3.49	Neutral	Best (1981)
1.50 - 2.49	disagree	
1.00 – 1.49	Strongly disagree	
Median		
≥ 4.00	High Level of Important	Ab Latif, Dahlan, Mulud, & Nor (2017)
≤ 3.50	Low Level of Important	
Standard Deviation: S.D.		
0.00 – 1.00	High Consensus	
1.01 – 1.49	Moderate Consensus	Henning & Jordaan (2016)
1.50 – 2.00	Low Consensus	
> 2.00	Without Consensus	
Inter-Quartile Range: IR		
0.00 – 1.00	High Consensus	
1.01 – 1.99	Moderate Consensus	Siraj & Ali (2008)
> 2.00	Without Consensus	
Quartile Deviation: Q.D.		
0.00 - 0.50	High Consensus	
0.51 – 1.00	Moderate Consensus	Fong, Ch'ng, & Por (2013)
> 1.00	Without Consensus	

4. Results

The research results focus on suitability results of the Hybrid Project-Based Learning Model on Metaverse as seen in Figure 2. The Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration.

Figure 2. The hybrid project-based learning model on metaverse to enhance collaboration

The Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration consists of four main components: Infrastructure, Hybrid Learning, Hybrid Project-Based Learning via Metaverse, and Collaboration. The lesson and classroom format includes 2 types: Synchronous Learning (Onsite/Online), and Asynchronous Learning (Onsite/Online). Additional information about each component is as follows:

Component 1: Infrastructure – Comprising 9 components: Instructors, Learners, Courses, Digital Content Tools, Virtual Activity Space, Hardware, Software, Network, and Database.

Component 2: Hybrid Learning – Comprising 4 components: Synchronous Learning which is Onsite Synchronous Learning and Online Synchronous Learning, Asynchronous Learning which is Onsite Asynchronous Learning and Online Asynchronous Learning.

Component 3: Hybrid Project-Based Learning via Metaverse – Comprising 6 steps: Step 1: Define the Problem, Step 2: Set Learning Objective, Step 3: Analyze to Plan, Step 4: Act or Solve a Problem, Step 5: Review and Evaluation, and Step 6: Conclude and Presentation.

Component 4: Collaboration – Comprising 5 components: Performance skills, Interaction skills, Communication skills, Listening skills and Summarizing ideas, and Systems thinking skills.

Results of the suitability study of the The Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration, as seen in Tables 7-8.

Table 7. Results of evaluation on the suitability of the hybrid project-based learning model on metaverse to enhance collaboration (Overall elements)

Items for evaluation	Mean	S.D.	Quartiles			IQR	Q.D.	Level of Agreement
			Q1	Median	Q3			
1. Infrastructure								
1.1 Instructor	5.00	0.00	5	5	5	0.00	0.00	Very High
1.2 Leanner	5.00	0.00	5	5	5	0.00	0.00	Very High
1.3 Course	4.86	0.38	5	5	5	0.00	0.00	Very High
1.4 Digital Content Tools	5.00	0.00	5	5	5	0.00	0.00	Very High
1.5 Virtual Activity Space	5.00	0.00	5	5	5	0.00	0.00	Very High
1.6 Hardware	4.86	0.38	5	5	5	0.00	0.00	Very High
1.7 Software	4.86	0.38	5	5	5	0.00	0.00	Very High
1.8 Network	4.86	0.38	5	5	5	0.00	0.00	Very High
1.9 Database	4.86	0.38	5	5	5	0.00	0.00	Very High
2. Hybrid Learning								
2.1 Synchronous Learning								
2.1.1 Onsite Synchronous Learning	4.86	0.38	5	5	5	0.00	0.00	Very High
2.1.2 Online Synchronous Learning	4.71	0.49	4.5	5	5	0.50	0.25	Very High
2.2 Asynchronous Learning								
2.1.1 Onsite Asynchronous Learning	4.86	0.38	5	5	5	0.00	0.00	Very High
2.1.2 Online Asynchronous Learning	4.71	0.49	4.5	5	5	0.50	0.25	Very High
3. Hybrid Project-Based Learning via Metaverse								
Step 1: Define the Problem	5.00	0.00	5	5	5	0.00	0.00	Very High
Step 2: Set Learning Objective	5.00	0.00	5	5	5	0.00	0.00	Very High
Step 3: Analyze to Plan	5.00	0.00	5	5	5	0.00	0.00	Very High
Step 4: Act or Solve a Problem	4.86	0.38	5	5	5	0.00	0.00	Very High
Step 5: Review and Evaluation	4.86	0.38	5	5	5	0.00	0.00	Very High
Step 6: Conclude and Presentation	5.00	0.00	5	5	5	0.00	0.00	Very High
4. Collaboration								
4.1 Performance skills	5.00	0.00	5	5	5	0.00	0.00	Very High
4.2 Interaction skills	5.00	0.00	5	5	5	0.00	0.00	Very High
4.3 Communication skills	5.00	0.00	5	5	5	0.00	0.00	Very High
4.4 Listening skills & Summarizing ideas	5.00	0.00	5	5	5	0.00	0.00	Very High
4.5 Systems thinking skills	5.00	0.00	5	5	5	0.00	0.00	Very High
Overall average	4.92	0.18	4.96	5.00	5.00	0.04	0.02	Very High

From Table 7, it was found that the overall suitability of the development to the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration (Overall Composition) It is at a very high level (Mean = 4.92, S.D. = 0.18, IQR = 0.04, Q.D. = 0.02) In conclusion, The Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration has all the elements that can be used as a guide for further development of the Hybrid Project-Based Learning Platform via Metaverse.

Table 8. The results of the evaluation certify the suitability of using the hybrid project-based learning model on metaverse to enhance collaboration

Items for evaluation	Mean	S.D.	Quartiles			IQR	Q.D.	Level of Agreement
			Q1	Median	Q3			
1. The Hybrid Project-Based Learning Model on Metaverse is suitable to promote Collaboration.	4.86	0.38	5	5	5	0.00	0.00	Very High
2. The Hybrid Project-Based Learning Model on Metaverse is appropriate for actual use.	4.57	1.13	5	5	5	0.00	0.00	Very High
Overall average	4.71	0.76	5	5	5	0.00	0.00	Very High

Table 8 shows that 1. Experts are of the opinion that the Hybrid Project-Based Learning Model on Metaverse is suitable to promote Collaboration. It is suitable at a very high level (Mean = 4.86, S.D. = 0.38, IQR = 0.00, Q.D. = 0.00) 2. The Hybrid Project-Based Learning Model on Metaverse is appropriate for actual use. It is suitable at a very high level (Mean = 4.57, S.D. = 1.13, IQR = 0.00, Q.D. = 0.00). Overall, in conclusion, the results of the evaluation certify the suitability of using the The Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration is suitable for actual use at a very high level (Mean = 4.71, S.D. = 0.76, IQR = 0.00, Q.D. = 0.00)

5. Conclusion and Discussion

According to the results of the suitability study of the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration. It was found that the overall suitability of the development the 5 model components (Overall composition) reach it's at a very high level consistent with the 1st and 2nd research objectives. In conclusion, the Hybrid Project-Based Learning Model on Metaverse to Enhance Collaboration has a full range of elements that can be used to guide the further development of a Hybrid Project-Based Learning Platform via Metaverse. The results of the evaluation are certifying the suitability of the model reach it's at a very high level and consistent with the 3rd research objective. All the result consistent with the research hypothesis. Align with the concept by Thonghaew and Chaijaroen (2020) that this model is expected to help learners develop collaboration by engaging in learning activities. It involves managing the course using Hybrid Learning elements with Project-Based Learning process on Learning Management System (LMS) via Metaverse to promote learner's Collaboration.

Aligned with the concept presented by Doungklang (2019) regarding project-based learning fostering democratic citizenship, listening to diverse opinions, collaboration, and Bamrungsetthapong et al. (2020) and Thanthong (2020) highlighting how hybrid learning enhances learning efficiency for learners, as learning can take place anywhere, anytime, catering to the needs of the 21st century. Additionally, both skills can also be stimulated through learning via Metaverse, as mentioned by Hongphanut (2023) suggesting that these innovations can be applied at all levels of learning management, aligning with the education management of the 21st century. This research can serve as a guide for designing and developing hybrid learning systems using project-based learning processes via metaverse to promote collaboration. This concept is based on a learning element, learning process, and learning technology to promote learner skills of 21st century.

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