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An Inquiry-Based Learning Platform Mixed with Game-Based Learning using Metaverse to Enhance Digital Literacy and Empathy Skills

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Abstract

The inquiry-based learning platform mix game-based learning using metaverse, or IBL platform mixed with GBL using metaverse, was developed with an intention to enhance digital literacy and empathy skills, which are regarded as essential skills in the 21st century. The IBL platform mixed with GBL using metaverse was designed with the combination of inquiry-based learning and game-based learning processes mixed with metaverse technology. The platform developed in this study is intended to create virtual learning experiences in which learners can use their avatars to interact with the environments and other learners in metaverse. The main objective of this research were to design and study the results of the IBL platform mixed with GBL using metaverse. The population derived from purposive sampling are nine experts from different institutions with experiences in the fields of development of instruction platform and instruction systems. The results of this research show that the design of the IBL platform mixed with GBL using metaverse in terms of elements is at highest level. According to the results of this research, it can be summarized that the IBL platform mixed with GBL using metaverse contains all appropriate components and it can be employed as a guideline for learning that focuses on problem-solving processes. It is believed that the learning of this style can encourage learners to practically perform analytical thinking process in a systematic manner, and meanwhile allow them to see through the problems with systematic thinking and with the aid of technology.

Keywords: inquiry-based learning, game-based learning, metaverse, digital literacy and empathy skills

1. Introduction

The exponential improvement of technologies at present and the changing social contexts have resulted in the changes of learning behaviors and styles of people in society. Particularly, the introduction of digital technologies has played a very significant role and can respond to the lifestyles of people in today's society. To illustrate, the advancement of digital technologies has paved ways for learning in the modern world, and meanwhile enabled learners to learn anywhere and anytime, which will further lead to lifelong learning (Rokaiphet & Chatwattana, 2024). Recently, the online learning in higher education has grown so rapidly that a number of institutions have begun to offer online courses so as to fulfil students' demands in terms of easy access and high flexibility (Zeng et al., 2024). The use of these information resources clearly reflects that learners who are detemined to succeed need to be good at digital strategies and able to apply their learning experiences in independent working, which can help them control their own learning quite effectively (Vargas-Mendoza & Gallardo, 2023). Therefore, educational institutions should promote and support learning in accordance to Education 4.0 by providing learners with encouragement and opportunities to demonstrate their potentialily and capabilities in collaboration.

Thailand 4.0 is a policy related to the development of economy, society, and cultures of Thailand, with a particular emphasis on the advancement of technology and innovation, in such a way that Thailand can be competitive with other countries in the international level. The government has set the strategies to transform the country's economy that relies mostly on the production of basic goods to the economy fueled by innovations, focusing especially on the use of digital technology to upgrade the education sector and the skills of workers in digital age (National Economic and Social Development Board, 2016). One of the key points of Thailand 4.0

emphasizes human resource development, which is designated to promote digital literacy, enhance the capabilities of personnel to catch up with technological changes, and facilitate suitable environments for learning and innovation. This is the reason why the Ministry of Digital Economy and Society has been promoting the projects related to "Digital Literacy" with an effort to enable people to use technology and information in a more effective manner (Ministry of Digital Economy and Society, 2016).

To fabricate the effective education systems with high quality and use them as main mechanisms to improve human potentialities and capabilities (Chatwattana, 2021), a number of higher education institutions have begun to adjust the formats of freedom and access to knowledge sources. At the meantime, these institutions have been preparing themselves in order to deal with the rapid changes in technology by developing digital innovations with an intention to create the society that can equip learners with the essential skills needed in the 21st century (Wanglang & Chatwattana, 2023). For instance, one of the most important skills in these days is the understanding and the management of digital technologies; thus, digital literacy is regarded as an essential issue in the management of new generation education at all levels (Suvandy et al., 2024). This is because digital literacy can enhance abilities and knowledge needed in using digital technologies and digital devices in an effective manner in different contexts, which is believed to lead to the sharing society in which information technology is utilized for the benefits of all. These skills are considered highly indispensable, especially for Thailand 4.0 that requires personnel to be well equipped with technical and innovative expertise. Thus, the development of learners in vocational education is placing an emphasis on the abilities to apply information technology and analytical thinking skills in order that learners are able to develop themselves and have potential to work (collaboration) in response to the demands of the s-curve industries (Office of the Education Council, 2017).

2. Systematic Review

2.1 Inquiry-Based Learning

Inquiry-based learning (IBL) is a learner-centered learning process that allows learners to ask questions, explore, research, and seek information by their own in order to answer questions. This style of learning is said to help develop learners' analytical thinking and problem-solving skills. Moreover, the inquiry-based learning also addresses the search for information in a systematic way, which will help learners improve their critical reading and data-driven decision-making skills (Tongjean & Yimngam, 2024).

2.2 Game-Based Learning

Game-based learning (GBL) is a learning approach that uses games to make the learning process sound more interesting and motivates learners to enthusiastically participate in learning. The earlier studies indicate that GBL could enhance the skills of critical thinking, deep learning, teamworking, and problem-solving, which are very important in the 21st century (Prensky, 2001).

2.3 Metaverse

As to the rapid growth and evolution of metaverse, this technology has been widely applied in the New Normal education management with an intention to promote continuous learning. Metaverse is a virtual world fabricated in a learning environment that blends the physical and digital worlds together. In metaverse, users are able to interact with one another through augmented reality and virtual reality technologies (Efendioglu, 2023). Basically, metaverse is employed to express a virtual universe based on everyday life, in which both real and virtual things can coexist (Akour et al., 2022). So, it can be said that all of the aforementioned features of metaverse not only allow learners to achieve self-directed learning through their own experiences, but also provide the new dimensions of engagement, socialization, and digital life, which is said to promote continuous learning.

Metaverse is a 3D virtual reality in which people can interact with one another in real time under virtual environments. To take part in and interact with others in metaverse, users must use virtual identities called "avatars", which can be customized to reflect their identities and creativity. In addition, the use of avatars is said to create more engagement and increase learners' interest (Mystakidis, 2022). Accordingly, metaverse is recognized as a virtual space that allows people to do varied activities together in virtual community, such as conference, meeting, communication, travel, or entertainment, with the aid of technologies and accessories (Suzuki et al., 2020).

2.4 Digital Literacy and Digital Empathy

Digital literacy (DL) is the ability to use digital technologies to search, analyze, and communicate information in an efficient manner. Digital literacy is considered an essential skill in the 21st century because it helps promote

the competencies and bodies of knowledge related to the effective use of digital technologies and devices in different contexts (UNESCO, 2018).

Digital empathy (DE) refers to the ability to understand and demonstrate empathy through digital media or online environments, particularly when communicating in virtual world, creating digital media, and collaborating and interacting with others in digital communities. In digital age, digital empathy has become more and more important and online media users should pay as much attention to this issue as they do in the real-life communication. Communication with others in a polite and empathetic way will maintain good atmosphere in virtual world and prevent the problems of bullying and harassment that can affect both health and daily life of all users (Friesem, 2016).

In reference to the principles and theories above, the researchers have had an idea to develop the IBL platform mixed with GBL using metaverse to enhance digital literacy and empathy skills, with an expectation that this platform can be employed as a guideline to enhance the skills related to both digital literacy and digital empathy. Thereby, these skills refer to the abilities to use digital technologies in an ethical way, understand how to communicate and interact with others with good manners, be considerate in digital world and while using social media, avoid using repulsive languages to gossip or accuse others, and avoid using digital technologies to threaten or bully others. All of these are also regarded as the new learning concepts that are consistent with the development of characteristics of the 21st century learners.

3. The Purpose of the Research

This study has the purpose research were to:

- Synthesis the conceptual framework of the IBL platform mixed with GBL using metaverse to enhance digital literacy and empathy skills.
- Design the IBL platform mixed with GBL using metaverse to enhance digital literacy and empathy skills.
- Study the results of the design the IBL platform mixed with GBL using metaverse to enhance digital literacy and empathy skills.

The following hypothesis are related to the results of evaluation on the suitability of the design the IBL platform mixed with GBL using metaverse to enhance digital literacy and empathy skills, including:

H_1: The results of evaluation on the suitability of the design the IBL platform mixed with GBL using metaverse to enhance digital literacy and empathy skills is at high level.

4. Method

The design of the IBL platform mixed with GBL using metaverse to enhance digital literacy and empathy skills, and the research methodology is as follows.

4.1 Population

The population derived from purposive sampling are nine experts from different institutions with experiences in the fields of development of instruction platform and instruction systems.

4.2 Data Collection and Analysis

The IBL platform mixed with GBL using metaverse to enhance digital literacy and empathy skills, the researchers have determined the tools used in the research as follows: (1) the IBL platform mixed with GBL using metaverse, and (2) the evaluation form on the suitability of the IBL platform mixed with GBL using metaverse. This evaluation form has been designed and developed by the researchers, which the questions in this evaluation form are made in line with the purpose of study. The analysis used the mean and SD.

4.3 Methodology

In designing the research methodology, the researchers adhered to the concepts of systems approach (Khemmani, 2018; Utranan, 1982), which can be concluded into three stages as shown in Figure 1.

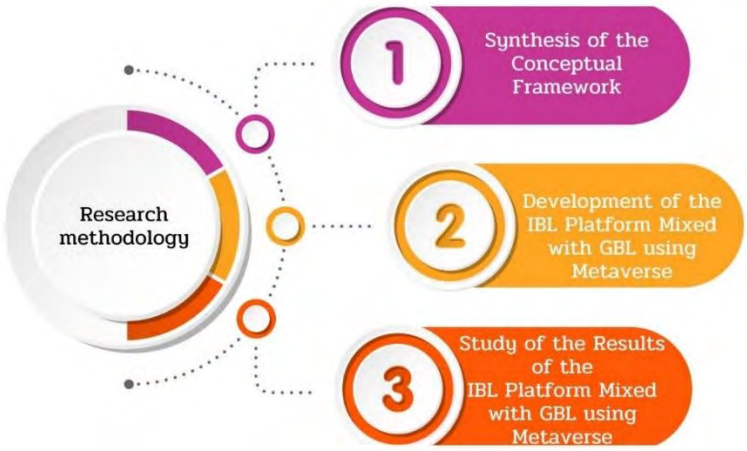

Figure 1. Methodology of the IBL platform mixed with GBL using metaverse

Figure 1 represents the methodology of the IBL platform mixed with GBL using metaverse, which is three stages as below:

Stage 1: The synthesis of the conceptual framework is conducted based on the study of systematic review i.e., inquiry-based learning, game-based learning, metaverse, digital literacy, and digital empathy. The conceptual framework of the IBL platform mixed with GBL using metaverse are shown in Figure 2.

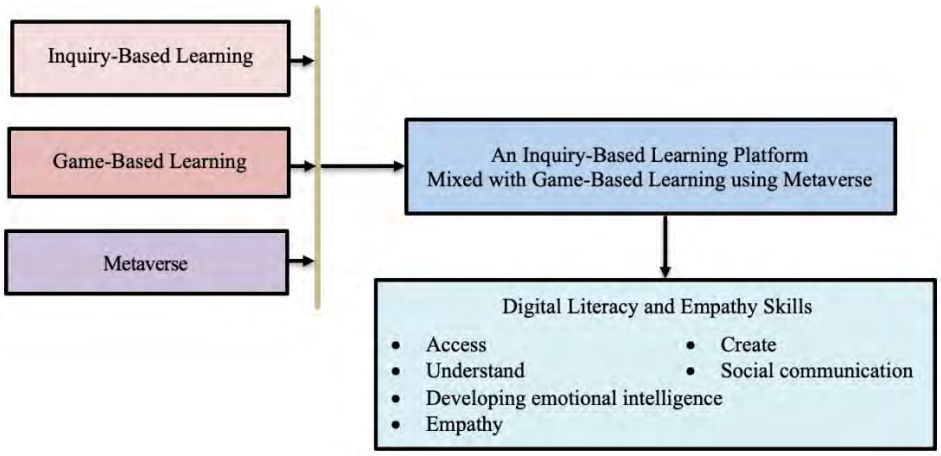

Figure 2. Conceptual framework of the IBL platform mixed with GBL using metaverse

Stage 2: The design of the IBL platform mixed with GBL using metaverse, the researchers based the design of this platform on the principles of systems approach (Khemmani, 2018; Utranan, 1982) is composed, i.e., input factor, the IBL process mix GBL using metaverse, output, and feedback.

Stage 3: The study of the results of the IBL platform mixed with GBL using metaverse, the researchers employed the criteria for evaluation and the interpretation of results (Srisa-Ard, 2010) to find out the results after having the participants use the said platform. The criteria for evaluation and the interpretation of results as below.

- Highest level, with a suitability score of 4.50 – 5.00,
- High level, with a suitability score of 3.50 – 4.49,
- Moderate level, with a suitability score of 2.50 – 3.49,
- Low level, with a suitability score of 1.50 – 2.49,
- Lowest level, with a suitability score of 0.00 – 1.49.

5. Results

The design of the IBL platform mixed with GBL using metaverse to enhance digital literacy and empathy skills

can be concluded as follows:

5.1 The Design of IBL Platform Mixed with GBL using Metaverse

The IBL platform mixed with GBL using metaverse was intended for use as a guideline to further design other inquiry-based learning platforms combined with game-based learning and the use of metaverse. It is projected that the learning platform of this kind can promote learners' digital literacy and empathy skills, which are the necessary characteristics in terms of thinking and solving problems in a systematic manner with the effective use of technologies. The design of the IBL platform mixed with GBL using metaverse is on the basis of systems approach (Khemmani, 2018; Utranan, 1982). The IBL platform mixed with GBL using metaverse as shown in Figure 3.

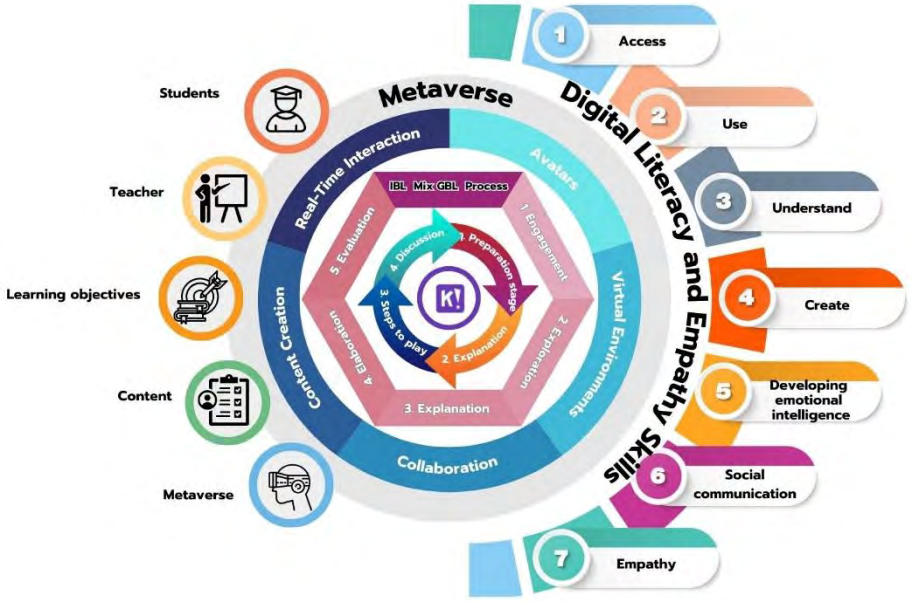

Figure 3. The IBL platform mixed with GBL using metaverse

Figure 3 illustrates the IBL platform mixed with GBL using metaverse, which consists of four main elements as follows:

1. Input factor: This refers to the environments and the elements that were used to design and develop the IBL platform mixed with GBL using metaverse in this study, i.e., students, teacher, learning objectives, content, and metaverse.

2. The IBL process mixed with GBL using metaverse: This element is the learning process that was designed from the concepts and principles of inquiry-based learning, game-based learning, and metaverse. Thereby, the details of these concepts and principles are as below:

2.1 Inquiry-based learning is a learning process in which learners have a significant role because they have to search for information, ask questions, and solve problems by themselves by means of inquiry and data analysis in order to find out solutions or conclusions. This process begins with arousing learners' curiosity in such a way that they want to ask questions about the topics of their interest. After that, learners are allowed to search and study information, and then do experiments in order to draw the conclusions from what they have discovered.

2.2 Game-based learning is a learning method that integrates games with learning process with an attempt to provide fun and stimulate learners' interest. Games are used as instruction tools to teach contents or skills, and learners can practice these skills while playing them. Therefore, the games for use in this learning style must be designed in compliance to the learning objectives.

2.3 Metaverse is a virtual world fabricated from digital technologies, in which people can engage in a variety of experiences in the forms of working, studying, playing games or socializing. Metaverse is a combination of virtual reality and augmented reality, so it allows users to interact with virtual environments therein in a lively way. In general, there are five elements needed in learning via metaverse (Mystakidis, 2022; Suzuki et al., 2020), i.e., avatars, virtual environments, collaboration, content creation, and real-time interaction.

Referring to the study and the synthesis on the documents and researches relevant to inquiry-based learning (Khumdee, 2018; Manosorn, 2019; Tongjean & Yimngam, 2024; Soruttayatorn, 2022; Gholam, 2019; Sotiriou et al., 2020; Wale & Bishaw, 2020; Sreejun & Chatwattana, 2023) and game-based learning (Sangarun & Khemcharoen, 2022; Prajong, 2019; Yangngoen, 2019; Buakhao, 2020; Adipat et al., 2021; Liu et al., 2020; Karakoc et al., 2020; Muengsan & Chatwattana, 2024), the researchers have received the guidelines to synthesize the inquiry-based learning process mixed with game-based learning using metaverse, as summarized in Table 1.

Table 1. Synthesis of the inquiry-based learning process mixed with game-based leaning using metaverse

Inquiry-based learning	Game-based learning	Inquiry-based learning process mixed with game-based learning using metaverse
1) Engagement	1) Preparation	1) Engagement 1.1) Preparation
2) Exploration	2) Explanation 3) Play the game	2) Exploration 2.1) Explanation 2.2) Play the game
3) Explanation	-	3) Explanation
4) Elaboration	4) Discussion	4) Elaboration 4.1) Discussion
5) Evaluation	-	5) Evaluation 5.1) Discussion

Table 1 represents the synthesis of the inquiry-based learning process mixed with game-based learning using metaverse based on the relevant documents and researches. The learning process derived herein can be summarized into five steps as below:

- Step 1 Engagement: The teacher connects the knowledge and experiences of the students via short activities in order to let them demonstrate their existing knowledge and skills. Challenging games are used in this stage to motivate the students to achieve the learning objectives, increase their enthusiasm to learn, and promote full participation in the game-based learning process. This stage contains only one step of game-based learning, i.e., preparation.
- Step 2 Exploration: The teacher supports the students in terms of data collection, data retrieval from activities, and application of existing experiences and knowledge to create new bodies of knowledge in the learning activities. In this stage, there are two steps of game-based learning process, which are explanation and play the game, respectively.
- Step 3 Explanation: The teacher allows the students to explain the experiences gained from the steps of engagement and exploration. After that, the teacher gives additional explanation for the students to have more knowledge and understanding.
- Step 4 Elaboration: The teacher allows the students to elaborate their knowledge and understanding in order to receive better understanding by applying their knowledge in the new scenarios. This stage includes one step of game-based learning, which is discussion.
- Step 5 Evaluation: It is about the discussion after playing the games. The teacher assesses the students' knowledge and understanding. At the meantime, the students should assess their own knowledge and understanding in order to summarize the results of game playing. This stage consists of one step of game-based learning, i.e., discussion.

3. Output: This element refers to the outcomes derived from the learning process, or digital literacy and empathy skills, which are the understanding and the use of technologies as well as the abilities to use digital technologies in an ethical way, be considerate in digital world and while using social media, avoid using repulsive languages to gossip or accuse others, and avoid using digital technologies to threaten or bully others. The output is categorized into seven aspects, i.e., access, use, understanding, creation, development of emotional intelligence, social communication, and empathy.

4. Feedback: This element is about the analysis of the data received from the learning process and the output, which are digital literacy and empathy skills, in order to use them to improve and optimize each step in the learning process so that the objectives of the IBL platform mixed with GBL using metaverse can be achieved. Besides, it is expected that this element is beneficial to the improvement and the development of this learning

model in the future, which is suitable to promote the essential skills of the 21st century.

5.2 The Study of the Design of the IBL Platform Mixed with GBL using Metaverse

In reference to the study results of the design of the IBL platform mixed with GBL using metaverse with nine experts from different institutions with experiences in the fields of design and development of instruction platform and instruction systems. The results of the architecture of the IBL platform mixed with GBL using metaverse are shown in Table 2 and Table 3.

Table 2. The overall elements on the design of the IBL platform mixed with GBL using metaverse

Evaluation lists	Results		Appropriateness
	Mean	SD	
1. What is the level of suitability of the principles and the concepts used to design the IBL platform mixed with GBL using metaverse?	4.78	0.42	Highest
2. What is the level of suitability of the elements of the IBL platform mixed with GBL using metaverse?			
2.1 Input factor	4.78	0.63	Highest
2.2 The IBL process mixed with GBL using metaverse	4.89	0.31	Highest
2.3 Output	4.89	0.31	Highest
2.4 Feedback	4.67	0.47	Highest
Total average	4.80	0.43	Highest

According to Table 2, it can be clearly seen that the overall elements of the development of the IBL platform mixed with GBL using metaverse is at highest level (Mean = 4.80, SD = 0.43). Therefore, it can be concluded that the IBL platform mixed with GBL using metaverse has all appropriate elements and it can be applied as a guideline to design the IBL platform mixed with GBL using metaverse to promote digital literacy and empathy skills, which are the characteristics of learners who can effectively apply technologies in systematic thinking and problem solving.

Table 3. Results of the assessment on the design of the IBL platform mixed with GBL using metaverse

Evaluation lists	Results		Appropriateness
	Mean	SD	
1. Input factor			
1.1 Students	5.00	0.00	Highest
1.2 Teacher	5.00	0.00	Highest
1.3 Learning objective	4.67	0.67	Highest
1.4 Content	4.89	0.31	Highest
1.5 Metaverse	4.44	0.50	High
2. The IBL process mixed with GBL using metaverse			
2.1 Inquiry-based learning (IBL)			
2.1.1 Engagement	4.78	0.42	Highest
2.1.2 Exploration	4.89	0.31	Highest
2.1.3 Explanation	4.89	0.31	Highest
2.1.4 Elaboration	4.89	0.31	Highest
2.1.5 Evaluation	4.78	0.42	Highest
2.2 Game-based learning (GBL)			
2.2.1 Preparation	4.89	0.31	Highest
2.2.2 Explanation	5.00	0.00	Highest
2.2.3 Steps to play	4.89	0.31	Highest
2.2.4 Discussion	4.78	0.42	Highest
2.3 Metaverse			
2.3.1 Avatars	5.00	0.00	Highest
2.3.2 Virtual environments	4.89	0.31	Highest
2.3.3 Collaboration	4.67	0.67	Highest
2.3.4 Content creation	4.89	0.31	Highest
2.3.5 Real-time interaction	4.89	0.31	Highest
3. Output			
3.1 Digital literacy and empathy skills			
3.1.1 Avatars	4.89	0.31	Highest

3.1.2 Virtual environments	4.89	0.31	Highest
3.1.3 Collaboration	5.00	0.00	Highest
3.1.4 Content creation	5.00	0.00	Highest
3.1.5 Real-time interaction	4.78	0.42	Highest
3.1.6 Content creation	4.89	0.31	Highest
3.1.7 Real-time interaction	4.78	0.42	Highest
4. Feedback			
4.1 Results of evaluation on digital literacy and empathy skills	5.00	0.00	Highest
Total average	4.89	0.24	Highest

Referring to Table 3, it is found that the overall suitability of the development of the IBL platform mixed with GBL using metaverse is at highest level (Mean = 4.89, SD = 0.24). This can be summarized that the IBL platform mixed with GBL using metaverse consists of such appropriate elements that it can be employed as a guideline for learning that focuses on problem-solving processes. Thereby, the learning of this style is believed to encourage learners to practically perform analytical thinking process in a systematic manner, and meanwhile allow them to see through the problems with systematic thinking and with the aid of technology.

6. Conclusion & Discussion

The IBL platform mixed with GBL using metaverse is a kind of learning platform via metaverse which was designed with the combination of inquiry-based learning, game-based learning, and metaverse technology in order to facilitate learners with virtual learning experiences while allowing them to interact with others and with virtual environments therein through their avatars.

According to the results of evaluation on the suitability of the design of the IBL platform mixed with GBL using metaverse, it is found that (1) the overall elements of the design of the IBL platform mixed with GBL using metaverse is at highest level (Mean = 4.80, SD = 0.43), and (2) the overall suitability of the design of the IBL platform mixed with GBL using metaverse is at highest level (Mean = 4.89, SD = 0.24). It can be concluded from the evaluation results that the IBL platform mixed with GBL using metaverse consists of all appropriate elements and it can be applied as a guideline to further develop other inquiry-based learning platforms mix game-based learning using metaverse to promote digital literacy and empathy skills.

The results herein are in accordance to the research of Sreejun & Chatwattana (2023), who stated that the application of virtual learning media in the instruction management using computer technology and information technology can yield real-time results and encourage learners to learn and control their own work independently. The findings are also consistent with the study of Manosorn (2019), who mentioned that inquiry-based learning is a learning management that encourages learners to ask questions, examine and analyze data, and think critically. This style of learning is said to improve the structure of knowledge and understanding through active learning facilitated by instructors. Inquiry-based learning also refers to the principles or methods that teachers adopt in the learning management process so as to develop their students. In addition, the results are also in line with the research of Prajong (2019), who said that, in order to make effective use of games in teaching, teachers must choose games that are appropriate and consistent with learning objectives. In other words, teachers must have experiences, knowledge, abilities, and skills in choosing the games. Not only that, teachers must know at which stage the game should be used because the games may be specifically effective only in specific stages, like introduction stage, teaching stage, or practice stage. Above all, teachers must use games at the right timing and occasions and the games must be consistent with needs, interests, and competencies of students.

7. Suggestions for Future Research

According to the discussion with the research participants by means of in-depth interviews, it is evident that the IBL platform mixed with GBL using metaverse still has some limitations that need to be addressed in the future. First of all, this research focuses mainly on the evaluation on the suitability of the design of the platform developed herein and the survey was conducted with only a small group of experts. Therefore, the future studies should be conducted with a larger and more diverse group of experts with more tests so as to confirm their suitability, validity, and reliability. Not only that, the techniques used to design this platform still have a limited scope of work. So, in order to put the future platforms in practical use effectively, the design should integrate a variety of technologies that can support and respond to the current situations. For instance, the platform design ought to have the features of real-time interaction via smartphone devices, accessibility anywhere and anytime, compatibility to several operating systems, etc.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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