Immersive Digital Storytelling Learning Experience with a Metaverse Gamification Game Platform to Enhance Game Developer Competency

Jaruwan Karapakdee* and Panita Wannapiroon

***Abstract*—This paper presents research on an immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency. The objectives were; 1) to develop an Immersive digital storytelling learning experience with a metaverse gamification; 2) to assess the game management architecture an Immersive digital storytelling learning experience with a metaverse gamification; 3) to assess a model for creating an immersive digital storytelling learning experience and; 4) to assess the game developer competency of students studying using an immersive digital storytelling learning experience with a metaverse gamification game platform. Research hypothesis is students using an Immersive digital storytelling learning experience with a metaverse gamification game platform and game development skills are perform at the highest level. The sample comprised 15 students at secondary school level 1 from Ongkharak Demonstration School, Srinakharinwirot University. Participants were recruited through multistage randomization. The research tool was a game developer assessment of learners using a realistic digital storytelling learning experience with a metaverse gamification gaming platform. The research results supporting the hypothesis were found to be at the highest level (mean = 4.97, S.D. = 0.18).**

***Index Terms*—Learning experience, immersive digital storytelling, metaverse, gamification, game developer competency**

I. Introduction

21st-century learning requires a strategic approach to learning management. This is achieved by jointly creating models and practices to enhance the efficiency of learning management, focusing on the knowledge, skills, expertise, and competencies of learners for use in a changing society. A model developed by partnership. For 21st-century skills provides a conceptual framework for 21st-century learning by combining various knowledge, applying specific skills, and bringing expertise and knowledge in all areas together for the success of students in both work and life [1]

Storytelling is based on bringing together stories. Existing from the original story from the book to magnetic stripe recording to apply patterns and processes with computer programs used to tell stories such as digital essays digital documentary, storytelling is generally described based on the concept of a diverse mix of narrative and multimedia arts.

Manuscript received September 5, 2022; revised October 2, 2022; accepted November 4, 2022.

Jaruwan Karapakdee is with Educational Research Development and Demonstration Institute, Srinakharinwirot University, Thailand.

Panita Wannapiroon is with King Mongkut's University of Technology North Bangkok, Thailand.

*Correspondence: jaruwanka@g.swu.ac.th (J.K.)

This includes graphics, audio, video, and web publishing [2], [3]. The nature of digital narrative education technology means it has enormous potential to be used to create patterns or a true learning context for all students regardless of background group of students [4].

The metaverse is a virtual world, a 3D virtual environment online, that has been used in video games. Today's creative universe ambitions center around addressing technological limitations with state-of-the-art VR and AR devices. The metaverse is a virtual world where users interact with a virtual environment where they can have a realistic online experience. In this universe, users are represented by avatars and can interact with other people and elements in the same environment [5–10].

Nowadays, games are not only played for entertainment, but it has also been used in education. The game mechanics are used to create interest in learning, and to generate motivation and excitement to form an effective learning environment. It is a tool for creating an easy-to-understand yet complex process using realistic everyday events. To use the advantages of games, lecturers design learning activities in the form of a game in order to motivate students to learn, improve and find solutions to problems [11].

Game developers are important for the production of games for the market. Game developers are responsible for creating higher quality and developing game systems using programming and coding to achieve processes such as the animations of games designed by Game Animators. Game developers also update versions of the game to reflect the changing technology. In addition to the techniques for creating games, creativity is also required for game design to be realistic [12].

Given the background and importance of the mentioned above, the researchers identified the need to develop and create an immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency. The students currently lack the Competencies needed for the place of work, and therefore games are used to the benefit of developing student and educational personnel with games. It is another form of teaching and learning promotion and can create awareness and understanding to see the importance of games when used to develop properly and appropriate.

II. Objectives of the Research

The objectives of the research are:

1) to develop an Immersive digital storytelling learning experience with a metaverse gamification.

2) to assess the game management architecture an Immersive digital storytelling learning experience with a metaverse gamification.
3) to assess a model for creating an immersive digital storytelling learning experience.
4) to assess the game developer competency of students studying using an immersive digital storytelling learning experience with a metaverse gamification game platform.

III. Scope of the Research

The population used for the research were junior high school students in Ongkharak Demonstration School, Srinakharinwirot University. The sample comprised 15 students at Secondary School level 1 in the academic year 2021, who were selected by multistage randomization.

Research Variables: The underlying variant is an immersive digital storytelling learning experience with a metaverse gamification platform. The dependent variable was game developer competency. The duration of data collection was 4 weeks. The content used in teaching was that of Design and Technology, M.1 course.

IV. Research Conceptual Framework

Research on creating an Immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency. The resulted in the information summarized shown in Fig. 1.

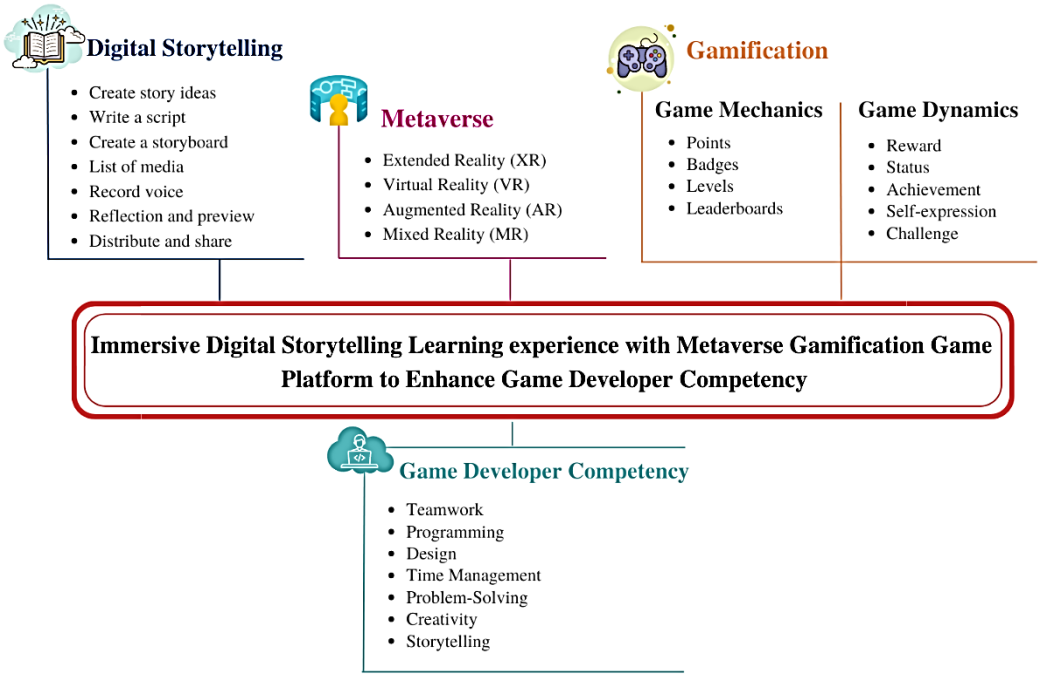

Fig. 1. A conceptual framework for creating an Immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency.

V. Literature Review

A. Digital Storytelling

Digital storytelling is the combination of stories and the use of technology as a teaching aid in the classroom. This can either be used as part of the curriculum design or part of what the students create. Typical technology that can be used are video recorders, cameras, audio recorders, computers, music, and other devices related to the production of various media [13, 14].

B. Learning Experience

In the conceptual framework of participative learning, one of the learning styles is the learning experience. This method of learning illustrates the connection between three dimensions: thinking, motivation, and the social context are all important factors that influence learning with teacher help. Setting up the environment for students to learn both inside and outside of the classroom is an activity that involves organizing experiences. Students' interactions with the environment's external circumstances interact with one another. The actions that students take are what lead to learning. In a nutshell, learning experiences are the activities that students engage in or their responses to various stimuli as a result of learning [15].

C. Metaverse

The metaverse is the universe created in a virtual reality. It is a perpetual and continuous multi-user environment that combines physical reality with digital virtual reality. It is based on the convergence of technologies that enable multisensory interactions with virtual environments, digital objects, and people, such as Virtual Reality (VR) and Augmented Reality (AR). It provides a comprehensive social and networking environment on a persistent multi-user platform. It enables seamless communication with figurative users in real-time and dynamic interactions with digital artifacts. Its first iteration is a web of virtual worlds which avatars can move between. The contemporary iteration of the

metaverse offers an immersive and social VR platform compatible with massively multiplayer online video games open game world and AR collaboration space [16].

D. Gamification

Gamification is a technique used in the form of a game without using the game itself. It helps to motivate students to learn and engages them in a fun way [16]. It used for creating activities in the form of a game without Pausing the game itself. It makes use of game mechanics like points and badges and game dynamics such as rewards, challenges Leaderboards, etc. Learning using Gamification is an important technique that keeps students interested and able to develop work systems, provide advice and transfer experiences and knowledge [17].

E. Game Developer

Game developers are those engaged in programming and coding including visualization and concept of the game and gamification elements, as well as choosing the method of execution. They must have a basic understanding of game marketing, game design techniques, team management skills, and teaching game development and project management, and can coordinate others involved in game development [18–21].

VI. Research Hypothesis

Students using an Immersive digital storytelling learning experience with a metaverse gamification game platform and game development skills are perform at the highest level.

VII. Research Methodology

This research was designed through 5 phases as follows:

Phase 1: synthesizes research on game developer competency from 7 related papers and research published in international academic journals between 2018-2020.

Phase 2: synthesizes research on the immersive digital storytelling process from 7 papers along with research related to the immersive digital storytelling process published in international academic journals between 2017-2021.

Phase 3: synthesizes research on the elements of gamification from 9 papers along with research related to gamefic elements published in international academic journals between 2018-2019.

Phase 4: development of an immersive digital storytelling universe platform game to empower game developers. This involves implementing a 5 steps System Development Life Cycle (SDLC) process [22], which is as follows:

Step 1: Requirement Analysis

The requirement analysis included a study of concepts, theories from documents, and research related to an immersive digital storytelling learning experience with metaverse gamification game platform to enhance game developer competency, along with the results of research on real-life teaching and learning conditions system user survey. Resources needed to manage learning and create a suitable learning environment are used in the development of the platform.

Step 2: Design

In the design step the focus is on using a learning management system architecture to design an immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency. The structure of the system is presented in Fig. 2 and Fig. 3.

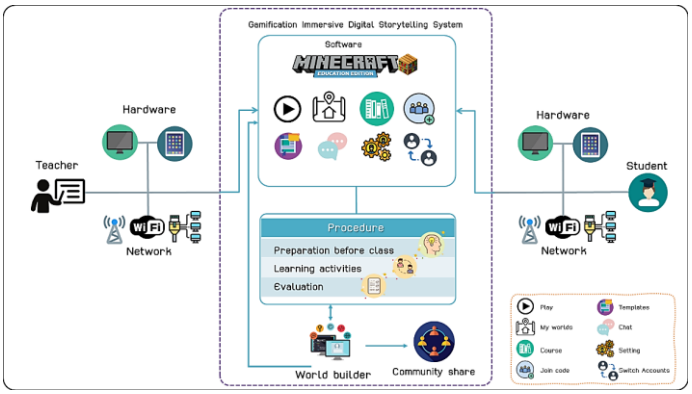

Fig. 2. Architecture design Immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency.

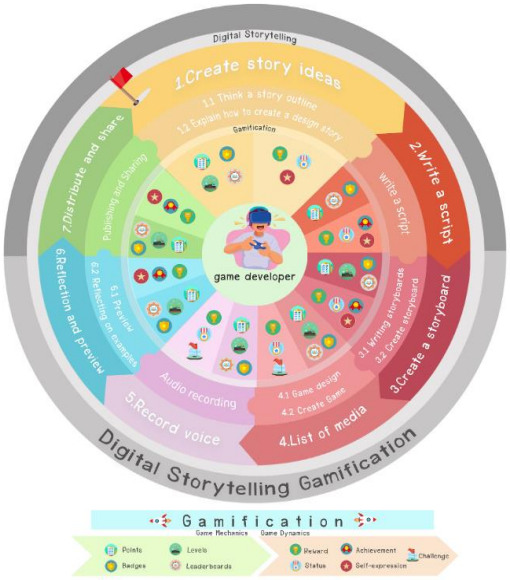

Fig. 3. Learning process Immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency.

From Fig. 3, the learning process of the Immersive digital storytelling learning experience with a metaverse gamification platform to enhance game developer competencies, was created.

This consists of the following 7 steps: 1) Create story ideas: 1.1) Think of a story outline, 1.2) Explain how to create a design story. The gamification consists of Points, Levels Badges, and Leaderboards. 2) Write a script: The gamification consists of Points, Badges, Leaderboards, Rewards, Status, Achievement, and Self-expression. 3) Create a storyboard: 3.1) Writing storyboards, 3.2) Create storyboards. The gamification consists of Points, Levels, Badges, Leaderboards, Reward, Status, Achievement, and Self-expression. 4) List of media: 4.1) Game design, 4.2) Create the game. The gamification consists of Points, Badges,

Levels, Leaderboards, Reward, Status, and Challenges. 5) Record voice, Audio recording. The gamification consists of Points, Badges, Levels, Leaderboards, and Reward, Status, and Challenges. 6) Reflection and preview: 6.1**)** Preview, 6.2**)** Reflection on examples. The gamification consists of Points, Badges, Levels, Leaderboards, Reward, Achievement, and Self-expression. 7) Distribute and share: Publishing and Sharing. The gamification consists of Points, Badges, Levels, Leaderboards, Reward, Achievement, and Self-expression.

Step 3: Development

The development step was two-fold:

1. Study the tools that support the immersive digital storytelling learning experience with metaverse gamification game platform to enhance game developer competency by considering appropriate tools according to the system structure designed and meeting analytical needs.

2. Develop an immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency by incorporating information to organize learning activities.

Step 4: Testing

In step 4 the overall performance of the system was tested by observing the responsiveness of the system's functionality and the performance of the entire system. A check for accuracy and completeness was also done.

Step 5: Implementation

Apply the developed platform to the sample to study the effects of using an immersive digital storytelling learning experience with metaverse gamification game platform to enhance game developer competency.

Phase 5: Assess the game developer competency of students using an immersive digital storytelling learning experience with a metaverse gamification game platform.

1. Students learn using this process for a duration of 4 weeks.

2. Assess the game developer competency of students using the game developer performance assessment.

3. Analyze the results of the game developer competency assessment of students studying using the platform.

VIII. Research Results

A. Synthesis Results in Game Developer Competency

The results of the synthesis of documents and research related to the competence of game developers, is presented in Table I.

TABLE I: Synthesizes Game Developer Competency

Game developer competency	Vitaliy [18].	ESCO is a Europe [19].	Skills Future Singapore [20].	Thailand Professional Qualification Institute. [21].	Career [23].	Eric [24].	University of Limerick (UL) [25].	Synthesis
Teamwork	✓	✓	✓	✓	✓	✓		✓
Programming	✓	✓	✓	✓	✓	✓	✓	✓
Design	✓	✓	✓	✓	✓	✓	✓	✓
Time Management	✓		✓	✓	✓		✓	✓
Problem-*Solving*	✓	✓	✓	✓	✓	✓	✓	✓
Creativity	✓	✓	✓	✓	✓	✓	✓	✓
Storytelling		✓	✓	✓	✓	✓	✓	✓

From Table I it is found that game developer competency consists of 7 sub-competencies as follows: 1. Teamwork, 2. Programming, 3. Design, 4. Time Management, 5. Problem-Solving, 6. Creativity, and 7. Storytelling.

B. Synthesize Results the Process Immersive Digital Storytelling

The Synthesize of papers and research related to the immersive digital storytelling process is presented in Table II.

TABLE II: Synthesize Results the Process Immersive Digital Storytelling

Digital Storytelling Process	Gürsoy [14].	Kotluk & Kocakaya [26].	Petit [27].	Júlia [28].	Imed [29].	Kaeophanuek et al. [30].	Mujtaba & Zuana [31].	Synthesis
Create story ideas	✓	✓	✓	✓		✓	✓	✓
Write a script	✓	✓	✓	✓		✓	✓	✓
Create a storyboard	✓	✓	✓	✓	✓	✓	✓	✓
List of media	✓	✓	✓	✓	✓	✓	✓	✓
Record voice	✓	✓	✓	✓	✓	✓	✓	✓
Collect media materials	✓			✓				
Edit media materials							✓	
Assemble all materials				✓		✓		
Publish materials	✓	✓		✓		✓		
Reflection and preview	✓			✓	✓	✓	✓	✓
Distribute and share	✓	✓	✓	✓	✓	✓	✓	✓

From Table II the digital storytelling process consists more prominent of 7steps: Create story ideas, write a script, create a storyboard, List of media, Record voice, Reflection and preview and distribute and share.

C. Synthesize Results Gamification Elements

Synthesize papers and research related to gaming elements. Presented in the form of a table consisting of an essay as shown in Table III.

TABLE III: Synthesize Gamification Elements

Gamification elements		Aebli [32].	Shen and Yoppe [33].	Özdener [34].	Huang *et al.* [35].	Yildirim [36].	Tsai and Lee [37].	Synthesis
Game Mechanics	Points	✓	✓		✓	✓	✓	✓
	Badges	✓	✓		✓	✓	✓	✓
	Levels		✓	✓	✓	✓	✓	✓
	Leaderboards	✓	✓	✓	✓	✓	✓	✓
	Virtual Good				✓			
Game Dynamics	Reward	✓	✓	✓	✓	✓	✓	✓
	Status	✓	✓		✓		✓	✓
	Achievement	✓		✓		✓		✓
	Self-expression		✓	✓	✓		✓	✓
	Challenge	✓	✓	✓		✓		✓

From Table III it can be concluded that the gamification elements are as follows: 1. Game mechanics include: Point, Level, Badges, and Leaderboards; 2. Game dynamics include: Reward, Status, Achievement, Self-expression, and Challenge.

In Fig. 4 an Immersive digital storytelling learning experience model with a metaverse gamification game platform to enhance game developer competency, is illustrated. The elements of this model is derived from the literature synthesis and consist of the following components: 1. Teamwork, 2. Programming, 3. Design, 4. Time Management, 5. Problem-Solving, 6. Creativity 7. Storytelling. The gamification aspect is divided into two components: 1. Game mechanics: Points, Levels, Badges, Leaderboards; 2. Game dynamics: Reward, Status, Achievement, Self-expression, Challenge.

Fig. 4. Immersive digital storytelling learning experience model with a metaverse gamification platform to enhance game developer competency.

D. Result of Develop the Platform Immersive Digital Storytelling Learning Experience with a Metaverse Gamification

The design results of the game developer competency of students studying using platform Immersive digital storytelling learning experience with a metaverse gamification are shown in Fig. 5.

Fig. 5. Show the design results of the game developer competency.

From Table IV it was found that from a summary of the literature on digital storytelling and gamification (Table IV) it is clear that the developed game platform of an Immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency includes: (1) Create story ideas including, Points, Badges, Levels, Leaderboards, Reward, Status, Self-expression; (2) Write a script including, Points, Badges,

Leaderboards, Reward, Status, Achievement, and Self-expression; (3) Create a storyboard including, Points, Badges, Levels, Leaderboards, Reward, Status, Achievement, and Self-expression; 4) List of media including, Points, Badges, Levels, Leaderboards, Reward, Status, and Challenge; 5) Record voice including, Points, Badges, Levels, Leaderboards, Reward, Status, and Challenge; 6) Reflection and preview including, Points, Badges, Levels, Leaderboards, Reward, Achievement, and Self-expression; 7) Distribute and share including, Points, Badges, Levels, Leaderboards, Reward, Achievement, and Self-expression shown in Fig. 6.

TABLE IV: DEVELOP PLATFORM AN IMMERSIVE DIGITAL STORYTELLING LEARNING EXPERIENCE WITH A METAVERSE GAMIFICATION GAME PLATFORM TO ENHANCE GAME DEVELOPER COMPETENCY

Digital Storytelling	Gamification	
	Game Mechanics	Game Dynamics
Create story ideas	Points, Badges, Levels, Leaderboards	Reward, Status, Self-expression
Write a script	Points, Badges, Leaderboards	Reward, Status, Achievement, Self-expression
Create a storyboard	Points, Badges, Levels, Leaderboards	Reward, Status, Achievement, Self-expression
List of media	Points, Badges, Levels, Leaderboards	Reward, Status, Challenge
Record voice	Points, Badges, Levels, Leaderboards	Reward, Status, Challenge
Reflection and preview	Points, Badges, Levels, Leaderboards	Reward, Achievement, Self-expression
Distribute and share	Points, Badges, Levels, Leaderboards	Reward, Achievement, Self-expression

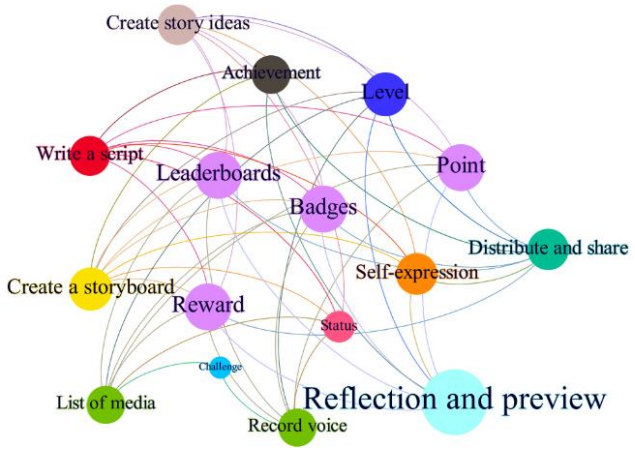

Fig. 6. Storytelling learning process with gamification.

E. Presents the Results of Assessing the Game Developer Competency of Students Using an Immersive Digital Storytelling Learning Experience with a Metaverse Gamification Game Platform to Enhance Game Developer Competency

The results of assessing the game developer competency of students using an immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency from the experts in assessing game developer competency show in Table V.

TABLE V: RESULT ASSESS THE GAME DEVELOPER COMPETENCY OF STUDENTS

Game developer competency	Student game developer assessment results		
	Mean	*S.D.*	Appropriateness
1. eamwork			
1.1 Work with others	5.00	0.00	Highest
1.2 leadership both for oneself and others	5.00	0.00	Highest
1.3 Accept the differences in the opinions of others	4.93	0.26	Highest
1.4 Listen to the opinions of others	4.93	0.26	Highest
Sum	**4.98**	**0.18**	**Highest**
2. rogramming			
2.1 Improve and develop the game to be effective properly	5.00	0.00	Highest
2.2 Test the functionality of the gan	5.00	0.00	Highest
2.3 Plan work in a systematic way	4.93	0.26	Highest
Sum	**4.97**	**0.15**	**Highest**
3. esign			
3.1 Apply knowledge from various sciences used to create games	4.93	0.26	Highest
3.2 Knowledge and understanding of the content of game design	5.00	0.00	Highest
3.3 Design work as a sketch	5.00	0.00	Highest
Sum	**4.98**	**0.15**	**Highest**
4. ime Management			
4.1 Design a detailed game concept and game scope for a specified period of time	4.87	0.35	Highest
4.2 A detailed description of the concept of the game and the scope of the game can be presented for a specified period of time	4.87	0.35	Highest
(2) Sum	**4.87**	**0.35**	**Highest**
5. roblem-Solving			
5.1 Identify problems and game requirements	5.00	0.00	Highest
5.2 Create games for solving problems in a systematic way	5.00	0.00	Highest
5.3 Apply concepts or methods for solving problems	4.93	0.26	Highest

Game developer competency	Student game developer assessment results		
	Mean	*S.D.*	Appropriateness
Sum	**4.98**	**0.15**	**Highest**
6. reativity			
6.1 Creative in game development	5.00	0.00	Highest
6.2 Ability to come up with new methods Design processes or concepts related to the game	5.00	0.00	Highest
6.3 There are new and interesting ideas in game development	5.00	0.00	Highest
Sum	**5.00**	**0.00**	**Highest**
7. torytelling			
7.1 Collect and analyze relevant plot ideas	4.93	0.26	Highest
7.2 Design and present the game's storyline	4.93	0.26	Highest
7.3 Improve and can summarize the plot of the game	5.00	0.00	Highest
(6) Sum	**4.96**	**0.21**	**Highest**
(7) Overall	**4.97**	**0.18**	**Highest**

From Table V students using the platform Immersive digital storytelling learning experience with metaverse gamification game platform exhibited enhanced game developer competency at the highest level (Mean = 4.97, S.D. = 0.18), which supports the research hypothesis. Specifically, students have creative competence at the highest level (Mean = 5.00, S.D. = 0.00) followed by design, problem solving (Mean = 4.98, S.D. = 0.15) and teamwork (Mean = 4.97, S.D. = 0.15)**,** respectively.

TABLE VI: THE RESULTS OF THE ASSESSMENT OF THE LEARNING MANAGEMENT ARCHITECTURE

Assessment details	Expert opinion		
	Mean	*S.D.*	Appropriateness
1. User **(**Student**)**			
1.1 Student	5.00	0.00	Highest
1.2 Teacher	4.00	1.00	High
2**.** Hardware			
2.1 Computer	5.00	0.00	Highest
2.2 Tablet	4.67	0.58	Highest
3. Network			
3.1 Cellular Network	4.67	0.58	Highest
3.2 Ethernet Network	4.33	0.58	Highest
3.3 Wi-Fi Network	5.00	0.00	Highest
4. Software			
4.1 Minecraft	4.67	0.58	Highest
5. Procedure			
5.1 Preparation before class	5.00	0.00	Highest
5.2 Learning activities	5.00	0.00	Highest
5.3 Evaluation	5.00	0.00	Highest
6. Result			
6.1 World builder	5.00	0.00	Highest
6.2 Community share	4.67	0.58	Highest
7. Appropriateness for implementing the structure of a metaverse gamification learning management system	5.00	0.00	Highest
8. Appropriate structure of a game learning universe in the form of metaverse gamification in the development of game developers	4.67	0.58	Highest
Overall	**4.78**	**0.47**	**Highest**

From Table VI The results of the assessment of the learning management architecture Immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency by an expert was found that the overall efficiency was at the highest level.

TABLE VII: THE RESULTS OF THE EVALUATION IMMERSIVE DIGITAL STORYTELLING LEARNING EXPERIENCE MODEL

Assessment details	Expert opinion		
	Mean	*S.D.*	Appropriateness
1. Immersive digital storytelling learning experience			
1.1 Create story ideas	4.83	0.41	Highest
1.2 Write a script	4.33	0.82	High
1.3 Create a storyboard	4.83	0.41	Highest
1.4 List of media	4.17	0.75	High
1.5 Record voice	4.33	0.52	High
1.6 Reflection and preview	4.33	0.52	High
1.7 Distribute and share	4.33	0.52	High
Sum	**4.54**	**0.59**	**Highest**
2. Learning the metaverse gamification			
2.1 Game Mechanics			
2.1.1 Points	4.83	0.41	Highest
2.1.2 Badges	4.83	0.41	Highest
2.1.3 Level	4.33	0.52	High
2.1.4 Leaderboards	4.50	0.55	Highest
Sum	**4.63**	**0.49**	**Highest**
2.2 Game Dynamics			
2.2.1 Reward	4.67	0.52	Highest
2.2.2 Status	4.83	0.41	Highest
2.2.3 Achievement	4.67	0.52	Highest
2.2.4 Self-expression	4.50	0.55	Highest
2.2.5 Challenge	4.67	0.52	Highest
Sum	**4.67**	**0.48**	**Highest**
Overall	**4.56**	**0.54**	**Highest**

From Table VII the results of the appropriateness evaluation Immersive digital storytelling learning experience model with metaverse gamification game platform to enhance game developer competency was found that the overall efficiency was at the highest level (Mean = 4.56, S.D. = 0.54). When considering Learning the metaverse gamification (Game Dynamics) at the highest level (Mean = 4.67, S.D. = 0.48). Followed by Learning the metaverse gamification **(**Game Mechanics**)** (Mean = 4.63, S.D. = 0.49), and Immersive digital storytelling learning experience (Mean = 4.54, S.D. = 0.59) respectively.

IX. CONCLUSION

By using the developed platform with a sample group to study the effects of using Immersive Digital Storytelling Learning experience with Metaverse Gamification Game Platform to enhance game developer competency, it was found that students who studied using the platform Immersive Digital Storytelling Learning experience with Metaverse Gamification Game Platform to enhance game developer competency at the highest level in accordance with

the established research hypothesis. This is consistent with research on Imagineering gamification using cloud technology to enhance innovative skills. The evaluation of the Imagineering gamification model was at an appropriate level. In addition, and consistent with on research which identified playing techniques effective from the point of view of rules, goals, problems, solutions, and suggestions that used elements similar to those mentioned above. The evaluation of an immersive digital storytelling learning experience model with metaverse gamification platform to enhance game developer competency by specialists indicated that overall, it had the highest level of appropriateness when applied to game developers. For research on Immersive Digital Storytelling Learning experience with Metaverse Gamification Game Platform to enhance game developer competency, the results of this summary can be used as a guide in other research studies.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Agree to research an immersive digital storytelling learning experience with a metaverse gamification game platform to enhance game developer competency. J.K. conducted research. analyze data, write articles, review and edit language. P.W. reviews and makes recommendations for presenting the results of data processing and conclusions. All authors have approved the final version.

FUNDING

The researcher would like to thank Educational Research Development and Demonstration Institute, Srinakharinwirot University, And Special thanks to the Innovation and Technology Management Research Center, King Mongkut's University of Technology North Bangkok which supported this research.

REFERENCES

[1] Office of the National Economics and Social Development Council, "National economic and social development plan no. 12 (2017–2021)," 2018.

[2] K. Daniels, "Exploring the impact of critical reflection through the use of service-learning and digital storytelling," *Journal on School Educational Technology*, vol. 9, no. 1, pp. 1–9, 2013.

[3] B. Ross Robin. (2008). Implementation of digital storytelling in the classroom by teachers trained in a digital storytelling workshop. [Online]. Available: https://www.researchgate.net/publication/233897526

[4] N. Chubko. (2020). Digital storytelling as an astr ytelling as an astronomy disciplinar onomy disciplinary liter y literacy enhancement approach for adolescent Kyrgyzstani EFL students. [Online]. Available: https://ro.ecu.edu.au/theses/2306

[5] H. Duan, J. Li, S. Fan, Z. Lin, X. Wu, and W. Cai, "Metaverse for social good: A university campus prototype," in *Proc. the 29th ACM International Conference on Multimedia*, Oct. 2021, pp. 153–161, doi: 10.1145/3474085.3479238.

[6] A. A. Gaafar, *Use of Fully Immersive Virtual Reality Techniques to Generate Scale 1: 1 Interactive Models of Pharaonic Tombs*, 2021.

[7] K. Hirsh-Pasek *et al.*, *A Whole New World: Education Meets the Metaverse*, 2022.

[8] J. Ju Hyun, "A study on education utilizing metaverse for effective communication in a convergence subject," *International Journal of Internet, Broadcasting and Communication*, vol. 13, pp. 129–134, 2021, doi: 10.7236/IJIBC.2021.13.4.129.

[9] S. Mystakidis, "Metaverse," *Encyclopedia*, vol. 2, no. 1, pp. 486–497, Feb. 2022, doi: 10.3390/encyclopedia2010031.

[10] B. Jongmuenwai, S. Lowanichchai, and S. Jabjone, "Comparison using data mining algorithm techniques for predicting of dengue fever data in northeastern of Thailand," in *Proc. International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology*, pp. 532–535, 2018.

[11] Garena. (Aug 28. 2021). *Game Developer*. [Online]. Available: https://www.garenaacademy.com/job/game-artist-dev/game-developer

[12] G. Gürsoy, "Digital storytelling: Developing 21st century skills in science education," *European Journal of Educational Research*, vol. 10, no. 1, Eurasian Society of Educational Research, pp. 97–113, Jan. 01, 2021. doi: 10.12973/EU-JER.10.1.97.

[13] P. Pattarasopasakul, "Digital storytelling in CNN's disaster news coverage," Dhurakijpundit University, Thailand, 2018.

[14] M. Ringo. (2020). Experience design PART 2. [Online]. Available: www.experiencedesignweek.com

[15] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, "From game design elements to gamefulness: defining gamification," in *Proc. the 15th International Academic MindTrek Conference Envisioning Future Media Environments*, pp. 9–15, 2011.

[16] F. Y. Wang, R. Qin, X. Wang, and B. Hu, "MetaSocieties in metaverse: MetaEconomics and MetaManagement for MetaEnterprises and MetaCities," *IEEE Transactions on Computational Social Systems*, vol. 9, no. 1, Institute of Electrical and Electronics Engineers Inc., pp. 2–7, Feb. 01, 2022, doi: 10.1109/TCSS.2022.3145165.

[17] H. J. Park and J. H. Bae, "Study and research of gamification design," *International Journal of Software Engineering and Its Application*, vol. 8, no. 8, pp. 19–28, 2014.

[18] H. Vitaliy. (Aug 28. 2021). *Game Developer Profession*. [Online]. Available: https://er.knutd.edu.ua/bitstream/123456789/14699/1/Kugai_Hlembotckiy_Game_developer_profession.pdf

[19] ESCO is a Europe. (Aug 30, 2021). *Digital Games Designer.* [Online]. Available: https://tinyurl.com/33tbcfsr

[20] Skills future Singapore. (Aug 30, 2021). *Singapore standard occupational classification 2020.* [Online]. Available: https://www.singstat.gov.sg/-/media/files/standards_and_classifications/occupational_classification/ssoc2020report.pdf

[21] Thailand Professional Qualification Institute. (Aug 28, 2021). *Game Programmer.* [Online]. Available: http://tpqi-et.tpqi.go.th/qualifications/standard/book?id=81&cer_level_id=2950

[22] R. Boggs, "Teaching object oriented systems analysis and design: a course model," *Issues in Information Systems*, vol. VI, no. 1, pp. 43–49, 2005, doi: 10.48009/1_iis_2005_43-52.

[23] K. Career. (Aug 28, 2021). *Game Development Industry*. [Online]. Available: https://tinyurl.com/2sapkh8n

[24] Z. Eric. (Aug 28, 2021). *Game Designer*. [Online]. Available: https://docplayer.net/1867846-Gaming-literacy-game-design-as-a-model-for-literacy-in-the-twenty-first-century.html

[25] University of Limerick (UL). (Aug 28, 2021). *Games Development*. [Online]. Available: https://www.ul.ie/courses/bachelor-science-computer-games-development#key-information

[26] N. Kotluk and S. Kocakaya, "The effect of creating digital storytelling on secondary school students' academic achievement, self-efficacy perceptions and attitudes toward physics," *International Journal of Research in Education and Science (IJRES)*, vol. 3, no. 1, pp. 218–227, 2017.

[27] E. Petit, "Digital storytelling for developing students' agency through the process of design: a case study," *Language Learning and Professionalization in Higher Education: Pathways To Preparing Learners and Teachers in/for the 21st Century*, 2020, pp. 137–166. doi: 10.14705/rpnet.2020.44.1104.

[28] B. Júlia. (Aug 28, 2021). *7 Digital Storytelling Tips for Your Nonprofit.* [Online]. Available: https://nonprofit.xarxanet.org/news/7-digital-storytelling-tips-your-nonprofit

[29] B. Imed. (Aug 28, 2021). *Digital Storytelling: Benefits, Examples, Tools & Tips*. [Online]. Available: https://research.com/education/digital-storytelling

[30] S. Kaeophanuek, J. Na-Songkhla, and P. Nilsook, "A learning process model to enhance digital literacy using critical inquiry through digital storytelling (CIDST)," *International Journal of Emerging Technologies in Learning*, vol. 14, no. 3, pp. 22–37, 2019, doi: 10.3991/ijet.v14i03.8326.

[31] M. Mujtaba and M. Zuana, "An attractive media to teach narrative text in speaking class," *ALSUNA: Journal of Arabic and English Language Digital Storytelling*, 2018.
[32] A. Aebli, "Tourists' motives for gamified technology use, " *Annals of Tourism Research*, vol. 78, 102753, 2019.
[33] Y. Shen and M. Joppe. (2019). Gamification in tourism advertising: Game mechanics and practices. [Online]. Available: www.whereami.com
[34] N. Özdener, "Gamification for enhancing Web 2.0 based educational activities: The case of pre-service grade school teachers using educational Wiki pages," *Telematics and Informatics*, vol. 35, no. 3, pp. 564–578, Jun. 2018, doi: 10.1016/j.tele.2017.04.003.
[35] B. Huang, K. F. Hew, and C. K. Lo, "Investigating the effects of gamification-enhanced flipped learning on undergraduate students' behavioral and cognitive engagement," *Interactive Learning Environments*, vol. 27, no. 8, pp. 1106–1126, Nov. 2019, doi: 10.1080/10494820.2018.1495653.
[36] I. Yildirim, "The effects of gamification-based teaching practices on student achievement and students' attitudes toward lessons," *Internet and Higher Education*, vol. 33, pp. 86–92, Apr. 2017, doi: 10.1016/j.iheduc.2017.02.002.
[37] T.-H. Tsai and L.-C. Lee, *Location-Based Augmented Reality for Exploration of Cultural Heritage*, 2017.