

The Development of Students' Creative Problem-Solving Skills Through Learning Model in Gamification Environment Together with Cartoon Animation Media

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Abstract

The aims of this study were to synthesize and evaluate the learning model in gamification environment together with cartoon animation media to promote students' creative problem-solving skills. This study was divided into three phases, (i) synthesized and evaluated the appropriateness of learning model (ii) developed cartoon animation and (iii) assessed creative problem-solving skills. The results show that the learning model consisted of three main components: teaching component, gamification environment, and activities to promote creative problem-solving. The overall suitability assessment of the developed learning model was averaged at 4.69 (SD = 0.46) out of 5, being at the most appropriate level and the scores of the students' post-learn creative problem-solving skills assessment were significantly higher than the criteria at the level .05. These results lead to a conclusion that the learning model in gamification environment together with cartoon animation media can significantly promote students' creative problem-solving skills and can be applied to develop desired learners' achievements and skills.

Keywords: gamification, cartoon animation, creative problem-solving skills, learning model

1. Introduction

The development of creative problem-solving skills promotes thinking skills to create a variety of ideas and think creatively based on a substantial foundation of theory and research to adapt use in situations which can be effectively applied in everyday life according to the context (Teffinger, 1995; Treffinger, 2006; Ellamil et al., 2012). These skills are necessary for learners in the 21st century (3Rs8Cs) (Office of the Education Council, 2017). The Basic Education Core Curriculum aimed to inculcate learners with the following five key competencies: communication capacity, thinking capacity, problem-solving capacity, capacity for applying life skills and capacity for technological application (Ministry of Education Thailand, 2008). Thus, the development of creative problem-solving skills is regarded as the important process to enhance thinking process of Thai students to generate diversified ideas which best suitable to the situations.

Learning design for 21st century learners require a shift in perspective from the traditional paradigm to the novel one. It is necessary to generate learning concepts which are in line with the student's learning behavior in order to stimulate their interest and participation in learning activities. The application of gamification concepts in teaching and learning activities can promote student engagement and stimulate the meaningful learning process (Marczewski, 2013; Nicholson, 2015). The application of game mechanics in a learning context without actually playing the game but applying the motivational technique of playing the game to achieve the objectives of the instructional activities can enhance the learning outcomes of the students (Poondej & Leerdpornkulrat, 2018). Game mechanics are the driving tools of gamification concepts that the user should design in the context which is appropriate to the learner (Kuo & Chuang, 2016). The examples of the game mechanics designed for teaching are points, levels, badges, leaderboard, time, mission etc. (Poonsawad, Srisomphan, & Sanrach, 2022; Kladchuen & Srisomphan, 2021). The success of gamification on education is tied to its potential to engage students in learning activities because engagement has been proved as positively correlated with outcomes of student success, including satisfaction, persistence, and academic achievements (Ibanez, Di-Serio, & Delgado-Kloos, 2014). When gamification is applied, the cognitive load factor must be considered and certain precautions must

be taken to maximize effectiveness (Turan et al., 2016). In addition, in the learning process, teaching materials have to be used as mediators to stimulate interest of students to learn effectively.

Animation is a teaching medium that is a technique of making immovable objects move and is considered to give life and soul to the created art to make it looks real (Ainsworth, 2008). This technique can easily attract the attention of the learner and significantly reduce the complexity of lesson due to the fact that the animation is clearer than either texts or images alone (Abdinejad et al., 2021; Yaseen, 2018). Educators have used animation as learning media and found that animation can positively change student achievement (Kaushal et al., 2021; Berney & Bétrancourt, 2016; Untari et al., 2020). Therefore, developing students to have creative problem-solving skills through learning activities with interesting learning materials by allowing students to construct their own knowledge and skills is the goal of this study. Specifically, the objectives of this study are (i) to synthesize and evaluate a learning model in gamification environment together with cartoon animation media to promote students' creative problem-solving skills and (ii) to evaluate creative problem-solving skills through learning model in gamification environment together with cartoon animation media.

2. Review Literatures

2.1 Cartoon Animation for Learning

Cartoon animation for learning is a teaching technique that applies computer graphics design to create animation with sound (Wells, 2013; Dobson, 2020). Most of the time, people tend to be interested in looking at colorful images or movements before receiving the content (Chaiyo et al., 2021), so if this technique is correctly applied to the stories related to the knowledge content, it will create interest for the audience while receiving the information (Klein & Shiffman, 2006; Yu & Tao, 2013; Hanif, 2020). Therefore, cartoon animation is a teaching tool that helps to simplify the complex stories to be easier to understand and promoting knowledge, understanding and remembering (Dalacosta et al., 2009; Zhang, 2012; Jalilian et al., 2016).

2.2 Gamification Learning

Gamification is the application of the basic mechanism of the game (Poondej & Leerdpornkulrat, 2018; Na-Songkla, 2018). such as experience points, levels, badges, quest, guild system, leaderboards, rewards, competition and progress bars (Bunchball, 2010; Zichermann & Cunningham, 2011; Poonsawad et al., 2022), not the game itself. Each element of the game mechanics related to human needs such as reward, status, achievement, self-expression, competition, altruism, etc., depending on how the game mechanics drive the main human needs (Kuo & Chuang, 2016) including human emotion. Emotions influence learning processes in at least three aspects: (i) in the presence of strong emotions, the concentration and readiness of the brain to learn increases, (ii) some emotions promote deep and connected learning, and (iii) emotions promote powerful learning (Cavanagh, 2016). Gamification can be applied in teaching and learning by simulating an environment like playing a game (Kapp, 2012; Marczewski, 2013). The implication of gamification leaning can enhance motivation, satisfaction, participation in activities, teaching efficiency, learning achievement and skills to improve student potential (Urh, Vukovic, & Jereb, 2015; Alsawaier, 2018; Nistor & Iacob, 2018).

2.3 Creative Problem-Solving

Creative problem-solving is the thought process of finding innovative solutions and allowing for unique and creative ideas (Treffinger, 2015; Proctor, 1999; Russ, 1999). It focuses on designing unique solutions and presenting the extraordinary ideas that may result from linking unexpected but useful and practical creative ideas (Puccio, 1999; Treffinger, 2006). This process begins with considering the problem together with searching for information and knowledge related to it. Consequently, a variety of different ways to solve the problems being generated before deciding on the best choice and applying it to solve problems (Torrance, 1965; Reiter-Palmon & Illies, 2004), resulting in more creative and efficient ways to solve difficult and complex problems (Guilford, 1967; Wang & Hornig, 2002; Hu, Xiaohui, & Shieh, 2017).

3. Method

3.1 Participants

This study included 9 participants who are computer or education experts in educational institutions, either public or private by purposive sampling. Their expertise is appropriate to develop learning model in focus group discussion.

In this study, there were two groups of samples. The first group of samples consisted of 12 participants selected by a specific method, who are instructors and experts holding master's degrees and knowledgeable in computational science, computer, evaluation or educational technology to determine the appropriateness of the

developed learning model. The second group of samples consisted of 42 participants selected by multi stages random sampling which consisting of 5 steps: selecting an educational service area office, district, school, student grade level, and classroom. The sample consisted of grade 8 students in the second semester of the academic year 2022, aged 13-14 years.

3.2 Instrument

The tools for this research are divided into two parts:

Part 1: Tools for Teaching Management

Cartoon animation medias were systematic development to shows the relationships between each other according to the ADDIE Model (Thienthong, 2011) 5 steps, namely 1) analysis, 2) design, 3) development, 4) implementation, and 5) evaluation.

The safe use of information technology lesson plan was designed to teaching together with cartoon animation for 8-week is shown in Table 1.

Table 1. The safe use of information technology lesson plan

No.	Topic	Week	Learning activity	Usage of cartoon animation
1	safe use of information technology	1	Explain the content together with animated media and discuss the content.	episode 1
	safe use of information technology	2	Practice solving problems from given situations and exchanging opinions.	
2	responsible use of information technology	3	Explain the content together with animated media and discuss the content.	episode 2
	responsible use of information technology	4	Practice solving problems from given situations and exchanging opinions.	
3	creation and ownership rights	5	Explain the content together with animated media and discuss the content.	episode 3
	creation and ownership rights	6	Practice solving problems from given situations and exchanging opinions.	
4	defining data usage rights	7	Explain the content together with animated media and discuss the content.	episode 4
	defining data usage rights	8	Practice solving problems from given situations and exchanging opinions.	

Table 1 shows the details of the safe use of information technology lesson plan in 8 weeks that use in learning activities.

A teaching website include the Google Classroom application using the Gamiplus extension to provide a gamification environment.

Part 2: Tools for Evaluation

A master model assessment form that evaluated learning model in gamification environment together with cartoon animation media which are principle, particulars and possibility of learning model were constructed using 5-rating scales (likert rating scales). The results of suitability were interpreted from the mean values as follows: very suitable (4.51–5.00), suitable (3.51–4.50), neutral (2.51–3.50), inapplicable (1.51–2.50), and very inapplicable (1.00–1.50)

A creative problem-solving skills assessment form, which is a holistic rubric 3-level qualitative assessment form, consisting of 4 aspects: 1) problem finding 2) idea finding, 3) solution finding, and 4) acceptance finding.

3.3 Procedure

This research was divided into three phases as followed:

Phase 1: Synthesized and evaluated the appropriateness of learning model. It was a study to find approaches for promoting creative problem-solving skills from document and relevant researches to synthesize data, develop and evaluate learning model by instructors and experts with master's degrees who have knowledge of computational science, computer, evaluation, or education. After that, the recommendations of experts were applied to improve the learning model.

Phase 2: Developed cartoon animation. It is the process of developing the learning materials which are

animations consisting of still images, drawings, sound clips which have been systematically developed according to the ADDIE model. This animation contains contents related to the safe use of information technology, consisting of 4 episodes: 1) safe use of information technology, 2) responsible use of information technology, 3) creation and ownership rights, and 4) defining data usage rights which has designed storyboards, developed, implement and evaluate cartoon animation media to obtain quality and use in a developed learning model.

Phase 3: Assessed creative problem-solving skills. It evaluates students' creative problem-solving skills after learning with a developed learning tool.

4. Results

4.1 The Synthesis Results of Learning Model in Gamification Environment Together with Cartoon Animation Media Promotes Students' Creative Problem-Solving Skills

In this study, the researcher studied, analyzed, and synthesized relevant documents and researches about learning in the century 21st, gamification learning environment, cartoon development for teaching and creative problem-solving concepts. The learning model was synthesized as followed:

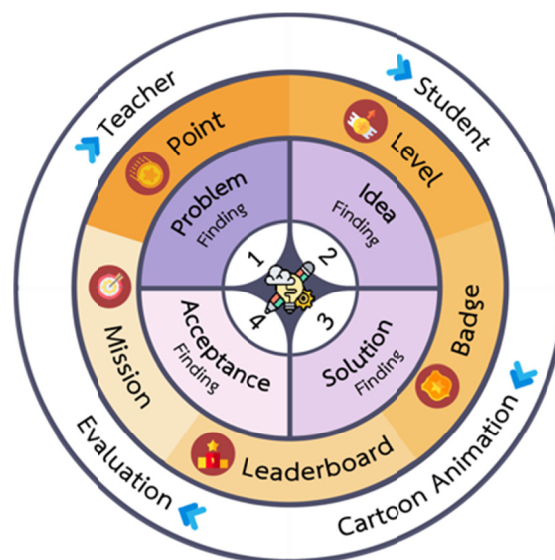


Figure 1. Learning model in gamification environment together with cartoon animation media promotes students' creative problem-solving skills

The learning model in a gamification environment together with cartoon animation media promotes students' creative problem-solving skills (Figure 1), consisting of 3 main components: 1) teaching components 2) gamification environment and 3) creative problem-solving activities which can be explained in detail as followed:

Component 1: Teaching components

Part 1: Teacher, This part is an important component of teaching and learning, which teachers should have the following skills: teaching skills, knowledge and understanding of the gamification environment, and have also to focus on creating a learning environment for learners to creatively solve problems according to the given situation through activities and learning materials to encourage students to have creative problem-solving skills.

Part 2: Student, It is the result of the implementation of the learning model, which was emphasis on learners' abilities and skills in knowledge, use of technology and problem-solving in a group working manner.

Part 3: Cartoon Animation, Cartoon animation is an important input factor in the process of promoting students' creative problem-solving skills. The knowledge content of this research is divided into 2 groups, namely main knowledge content in 4 topics and supplementary knowledge content.

Part 4: Evaluation, It is an assessment of creative problem-solving skills using a holistic rubric 3-level qualitative assessment form.

Component 2: Gamification environment

The researchers synthesized gaming environments from Poonsawad et al. (2022), Zichermann and Cunningham (2011), Kapp (2012), Huang and Soman (2013), Dale (2014) summarized as followed.

Part 1: Point, It is an important element that is scored when a mission or agreement is accomplished. Points will be accumulated until the end of the event. In this research, the researcher used google classroom to assign various tasks such as thought provoking questions, group tasks, and worksheets, in which the students will receive scores after completing the tasks and the teacher will give them points.

Part 2: Level, It determines the grade level of the accumulated points of the learners who have received it. If a learner earns a certain number of points, they will be promoted to a higher level (Beginner level: 0–30 points, Elementary level: 31–50 points, Intermedia level: 51–70, Advanced level: 71–80, Expert level: 81–100 points).

Part 3: Badge, It is a sign that shows the achievement of one of the goals of the mission or shows the special characteristics of the learner. The researcher applied the Gamiplus website to create behavioral badges consistent with the desirable characteristics of learners in 4 behaviors: discipline, eager to learn, commitment to work, and public mind by observing the behavior of individual learners on a periodic basis.

Part 4: Leaderboard, It is the mechanics of the game that motivate the learners to feel challenged to compete with others. It is a system showing cumulative scores sorted by students who received the highest cumulative score, motivated to complete the task and had the best score. The researcher summarized the cumulative scores, levels and badges. of students are weekly announced in Google Classroom and listed with the top 10 highest scorers on the grade board.

Part 5: Mission, It is a goal outcome to win or solve a problem which aims to make the learner challenged, motivated to earn a reward or score as a result of achievement of a goal. The researcher assigned a task after receiving knowledge by watching animation cartoons and learning activities.

Component 3: Activities to promote creative problem-solving

The researchers synthesized Activities to promote creative problem-solving from educators Phantipa (2016), Chutsuriyawong and Nillapun (2016), Ngiwklang and Chanawong (2019), Higgins (1994), Parnes (1963) summarized as followed:

Step 1: Problem finding, It is the process of presenting the problem and finding the root causes of the problem by searching for information thoroughly before deciding to determine the problem. It is consisting of brainstorming to find the cause of the problem and searching for information from various sources before deciding on the problem, identify problems that need to be solved clearly and reasonably.

Step 2: Idea finding, It is the main step from diligently trying to think, hypothesize and collect information on a variety of innovative solutions, both the main approach with reasoning and additional approaches that are based on logic and intuition. In addition, it can also specify the details of the solution that can be thought of as well, including presenting new solutions to problems that are different from ordinary ideas. (initiative), has a keen commitment to think of a variety of solutions (fluid thinking) and identifying a step-by-step solution to a problem (detailed thinking).

Step 3: Solution finding, It is a decision to choose the best way to solve a problem. This decision can predict what advantages and disadvantages will be found and can provide other related examples that are similar or different in solving the problem, consisting of choosing a solution that the selected group of students can actually solve the problem, give examples of situations related to the solution (flexible thinking), carefully consider the pros and cons of the selected solution.

Step 4: Acceptance finding, It identifies a problem-solving action plan, assuring the feasibility of a solution by seeking information about the availability, utilization of people's abilities and limitations, context, conditions, resources, obstacles to solving the problem, consideration, and problem-solving analysis in many different perspectives. It helps to make the action plan acceptable and into reality, consisting of: find methods and tools that facilitate the problem-solving process, identify the effects on yourself and others, and anticipate obstacles that may arise between problem-solving and preventive measures.

After the researcher synthesized the learning model, 12 experts assessed its suitability using a qualitative evaluation form consisting of 1) principles and concepts of the teaching and learning model, 2) details of each component and 3) the possibility of the teaching and learning style using the mean and standard deviation (SD). The evaluation has assessed and given suggestion with using 5-rating scales in 3 sections as follows:

Section 1: Principles and concepts of learning model in a gamification environment together with cartoon

animation media promotes students' creative problem-solving skills.

Section 2: Details components of learning model in a gamification environment together with cartoon animation media promotes students' creative problem-solving skills.

Section 3: Possibilities of learning model in a gamification environment together with cartoon animation media promotes students' creative problem-solving skills.

The suitability assessment results of principles and concepts for learning model in a gamification environment together with cartoon animation media promotes students' creative problem-solving skills is shown in Table 2.

Table 2. The suitability assessment results of principles and concepts

Description	Average	Standard Deviation	Interpretation
1. Appropriateness of principles for developed learning model	4.83	0.39	very suitable
2. Suitability of learner's characteristics for concepts of learning model	4.75	0.45	very suitable
3. Appropriateness of learning process	4.56	0.50	very suitable
Overall Section 1	4.65	0.48	very suitable

Table 2 shows the suitability assessment results of principles and concepts for developed learning model in section 1 which had overall evaluation in very suitable level (Mean = 4.65, SD = 0.48).

The suitability assessment results of details components for learning model in a gamification environment together with cartoon animation media promotes students' creative problem-solving skills is shown in Table 3.

Table 3. The suitability assessment results of details components

Description	Average	Standard Deviation	Interpretation
Component 1: Teaching components	4.73	0.45	very suitable
Part 1: Teacher	4.92	0.29	very suitable
Part 2: Student	4.75	0.45	very suitable
Part 3: Cartoon Animation	4.58	0.51	very suitable
Part 4: Evaluation	4.67	0.49	very suitable
Component 2: Gamification environment	4.70	0.46	very suitable
Part 1: Point	4.67	0.49	very suitable
Part 2: Level	4.67	0.49	very suitable
Part 3: Badge	4.83	0.39	very suitable
Part 4: Leaderboard	4.58	0.51	very suitable
Part 5: Mission	4.75	0.45	very suitable
Component 3: Activities to promote creative problem-solving	4.73	0.45	very suitable
Step 1: Problem finding	4.75	0.45	very suitable
Step 2: Idea finding	4.75	0.45	very suitable
Step 3: Solution finding	4.67	0.49	very suitable
Step 4: Acceptance finding	4.75	0.45	very suitable
Overall Section 2	4.72	0.45	very suitable

Table 3 shows the suitability assessment results of principles and concepts for developed learning model in section 2 that is had overall evaluation in very suitable level (Mean = 4.72, SD = 0.45).

The suitability assessment results of possibilities for learning model in a gamification environment together with cartoon animation media promotes students' creative problem-solving skills is shown in Table 4.

Table 4. The suitability assessment results of possibilities

Description	Average	Standard Deviation	Interpretation
1. Appropriateness of learning model in a gamification environment together with cartoon animation media and students' creative problem-solving skills	4.83	0.39	very suitable
2. Appropriateness of the steps and activities of the learning model in a gamification environment together with cartoon animation media and students' creative problem-solving skills	4.33	0.49	very suitable
3. Possibility of practical application of the learning model.	4.83	0.39	very suitable
Overall Section 3	4.67	0.48	very suitable

Table 4 shows the suitability assessment results of possibilities for developed learning model in section 3 that is had overall evaluation in very suitable level (Mean = 4.67, SD = 0.48).

The suitability assessment results for learning model in a gamification environment together with cartoon animation media promotes students' creative problem-solving skills, summarizing the results from the evaluation of all 3 sections, which were found an average of 4.69 (SD = 0.46) in very suitable level.

4.2 The Comparison of Creative Problem-Solving Skills of Post-Learning Students with Learning Model Synthesis in a Gamification Environment Together with Cartoon Animation Media

In this research, we assessed creative problem-solving skills by observing the behavior of individual students throughout the learning process using the holistic rubric qualitative assessment form, 3 levels, 4 areas consist of: 1) problem finding, 2) idea finding, 3) solution finding, and 4) acceptance finding, each of which consists of 3 subevaluation items, each with 3 points each, totaling 36 points, which has set the criteria of 80% of the scores that have analyzed the data to compare the mean with the criteria. The result is summarized in Table 5.

Table 5. The results of comparing creative problem-solving skills with the criteria

	n	Total score	Mean	S.D.	% Of Mean	t	Sig(1-tailed)
Post-learning	42	36	31.90	2.21	88.62	9.12*	0.0000

Note. *p < .05 t(.05, df 41) t = 1.68.

We compared the creative problem-solving skills of students after learning with learning model in a gamification environment together with cartoon animation media against the specified criteria. The assessment of post-learning students' creative problem-solving skills using developed learning model showed the average score of 31.90 points, representing 88.62%. The comparison between the criteria and the scores of students' post-learn creative problem-solving skills assessment showed that the scores of the students' post-learn creative problem-solving skills assessment scores were significantly higher than the criteria at the level .05. Thus, the learning model in gamification environment together with cartoon animation media can significantly promote students' creative problem-solving skills.

5. Discussion and Conclusion

The learning model in a gamification environment together with cartoon animation media promotes students' creative problem-solving skills. By studying related research and document, three components were found, teaching components, gamification environment and creative problem-solving activities and the learning process. Media tools in the form of animation, making learning process more interesting and exciting. In addition, a gamification environment has been applied in which students receive accumulated points and compete for more motivation to stimulate learning. The use of animation and gamification environment in learning process is a way to increase achievement and learning skills which are desired to be developed in accordance with the previous studied (Abdinejad et al., 2021; Yaseen, 2018; Phantipa, 2016; Eabsrangky & Nenthien, 2016; Vongtathum, 2015; Kongpiboon, 2023).

Experts provide their opinions and overall assessments that the learning model in a gamification environment together with cartoon animation media promotes students' creative problem-solving skills are most appropriate. This is because the learning model is developed based on principles, concepts and theories of cooperative learning with game elements to increase motivation and inspire learning by analyzing and synthesizing such concepts and theories. Learning activities can be developed by focusing on activities together with the use of cartoon animation for students to learn and jointly think creatively to solve problems in thoughtprovoking questions and worksheets which the teacher sets.

Implementation of the developed learning model, we evaluated the creative problem-solving skills of individual students by observing their learning behavior in class, their participation in answering questions, group activity behavior and encouraged the students to express creative problem-solving skills which can synthesize 4 elements, namely problem finding, idea finding, solution finding and acceptance finding.

We compared the criteria and the scores for assessing creative problem-solving skills after learning of students. The result show that the scores for assessing creative problem-solving skills after learning were higher than the criteria of 80 percent with statistical significance at the level of .05. Because of learning model encourages students to search for answers from thought-provoking questions that have been set in every class, thus gaining knowledge and being able to analyze and find solutions to problems from the specific situations Furthermore,

they also search and discuss group conceptual information using elements of creative problem-solving. The present ideas for student to exchange their information with other groups of classmates can be facilitated by the teachers. Students are motivated to think and express themselves, resulting in good learning and creative thinking skills, in line with previous studies (Meadow et al., 1959; Rawlinson, 2017; Seechaliao, 2017) that, problem-solving uses the imagination to find a solution by brainstorming within a group where every idea is presented without criticizing and judging whether the idea is good or bad, but showing a variety of ideas to make it possible to choose an effective solution to the problem. In addition, the learning process is stimulated by gamification (Marasco et al., 2015; Wanglang & Chatwattana, 2023) and cartoon animation (Kim et al., 2013), that create a positive classroom environment, which can be considered as an important factor for students' creative problem-solving skills.

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Authors' contributions

Asst. Prof. Dr. Siripon Saenboonsong developed the main idea of this research, developed the model and collected research data. Dr. Akarapon Poonsawad analyzed the research results, wrote and edited the manuscript. Both authors reviewed the final version of this manuscript for publication.

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Competing interests

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Obtained.

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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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