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Supplementing Elementary Science Learning with Multi-player Digital Board Game: A Pilot Study

Sasivimol PREMTHAISONG & Niwat SRISAWASDI*
Faculty of Education, Khon Kaen University, Thailand
*niwsri@kku.ac.th

Abstract: Educational games or serious games are playing an important role to facilitate today's student learning preferences and promote their motivation to learn in subject contents. Currently, many researchers revealed that digital game-based learning could promote students' motivation and their interest for learning by addressing abstract and complicated concept with mechanics of game. To examine a preliminary effect of supplementing primary school students' learning in science, a multi-player digital board game has been created and then implemented to 6 third-grade students (1 male and 5 females) in a local public school in the northeastern part of Thailand. They received the board game learning experience in a 100-minutes supplementing activity after their completion of conventional science lesson on living and non-living things. The results showed that they positively accepted the learning and playing with digital board game in general science topic about living things and non-living things. Furthermore, the students expressed positive perception towards the learning by playing with the digital board game. The main contribution of this study using digital board game-based learning to enhance students learning perception in science learning.

Keywords: digital game, game-based learning, educational game, collaborative inquiry, perception

1. Introduction

The advancement of digital technology in education could be used to promote authentic and active learning for new generation learner. In recent years, educators, researchers, developers, and teachers have attempted to apply digital game technology to create edutainment learning environment by adding educational purposes into digital games that are educational games or serious games (Cheng et al., 2013). Digital game-based learning is a pedagogical type of constructivist-oriented learning approach that has positive learning outcomes for students. According to the popular of digital game and its important role in our society, particularly younger generation or children who like to play game as a favorite, many studies have demonstrated that educational digital game could be used to promote student learning performances and their learning motivation (Wang & Chen, 2010; Liu & Chu, 2010; Harris & Reid, 2005). In the same way, Sung and Hwang (2013) collaborates a game-based learning environment by integrating a grid-based mindtool for students to share and organize during the game-playing process. Moreover, developing game-based learning could enhance students' motivation, perception and learning outcome in science class (Meesuk & Srisawasdi, 2014; Kitchawalit & Srisawasdi, 2015; Hiangsa, Srisawasdi, & Feungchen, 2015; Kanyapasit & Srisawasdi, 2014; Srisawasdi & Panjaburee, 2019). These results revealed that the pedagogical applications of educational digital game could enhance not only students' learning achievement but also their attitude towards learning and motivation to learn in science courses.

Due to the growth of digital technology in today's society, digital board game is one of learning technology that used to engage today students' learning, and also foster their motivation and interest in the learning of content subjects (Agca & Özdemir, 2013). The potential of digital board game in order to promote students' attitudes toward learning and increase their learning performance has been mentioned by educational researchers and developers. In the learning with digital board game, it is similar to playing with a computer game that can make student learning more enjoyable and challenge

in order to accomplish their own learning. The term of digital game refers to any game played using electronic device that employs consistent rules or constraints, has a clear goal, provides feedback and monitors progress via scores or other methods. The digital board game made of a game board, illustration cards, a text description, and some digital characteristics that players could use to interact with the game. In addition, a digital board game provides an interactive and interesting platform for learner. For instances, Zheng, Cheng and Chen (2018) integrated board game into computer software (called organ savior game) to explore students learning effectiveness in the health and physical course. These results showed that using organ savior game can enhance students' learning achievement. By the way, Juńior, et. al (2020) designed a board game consisting of one physical board, a few cards, and one mobile application about the reactions of organic compounds. The result of this study indicated that this kind of game could be effective learning tool to support students better learning in the organic reactions. Furthermore, using a digital board game in vocabulary languages learning can enhance students' learning interest (Ali, et al., 2018). Consequently, digital board game seem to be a pedagogic choice as technology-enhanced science learning that could apply to promote students' learning in science-oriented concepts. As such, it should be utilized as pedagogic learning tool in order to transform and create an innovative learning approach in science education.

2. Literature Review

2.1 Game-based Learning in Education

In the last decade, several researchers have attempted to integrate content knowledge with games for learning that calls educational games or serious games (Sorensen & Meyer, 2007; Stone, 2008). Using games in education has demonstrated positive learning outcomes. For example, Hsu, Tsai and Wang (2012) investigated the effect of using a computer game with the self-explanation principle in elementary school about light and shadow. This finding showed that students have a high-engagement in terms of the posttest and the retention test. In the same way, game features could affect the development of children's engagement (Ronimus et. Al., 2014). Furthermore, various studies have explored students' motivation by using the game in education. For instance, Huizenga, et. al., (2009) used a mobile game that calls Frequency 1550 in education integrated situation with active learning to enhance students' motivation and historical knowledge for History in general and the topic of the Middle Ages in particular. Similarly, Gamlo (2019) demonstrated that the use of mobile-game based language learning applications (MGBLLAs) could improve students' motivation to learn English.

2.2 Digital Board Game in Education

Recently, many different types of educational games are used and applied for learning in school. The board game is one of the educational games to enhance students' motivation, perceptions, and participation of learning in the classroom. Moreover, many researchers have developed a board game with digital technology suitable for students in the 21st century. Zheng, Cheng, and Chen (2018) used an electronic board game called organ savior game to teach health and physical education for elementary school students. This research demonstrated that students could enhance learning achievements in learning human internal organs and health information. Using a digital board game for the purpose of vocabulary learning in language can supports students to learn vocabulary (Ali et. al., 2018).

According to the aforementioned, Digital board game is an essential educational tool for all student to relate with content knowledge and provide students interaction through physical devices to develop students' knowledge learning. Furthermore, integrating a learning subject with a digital board game can improve students' learning affectiveness. For instance, Wu, Chen and Huang (2014) provided a digital board game language learning set for English classroom learning. This study found that instruction could be improved communicative skills and intrinsic motivation for EFL language learning. Consequently, our research attempted to integrate a digital board game with content knowledge to apply for classroom learning.

3. Research Methodology

3.1 Research Design

The one-group posttest only design was set up to study the effect of using game-based learning with a board game for science learning about living things and non-living things. This research used qualitative methodology as the study platform. Qualitative research methodology within phenomenological research design was used to explore primary school students' perceptions towards supplementing science learning with digital board game.

3.2 Participants

The participants of this study were six third-grade students (one male and five females), age ranging from 8-9 years old in a university-based school located in the northeastern region of Thailand.

Research Instruments

An interview protocol has been developed for this study regarding the theory of Technology Acceptance Model (TAM) in order to examine students' learning perception after interacting with a supplementing digital board game crated by the authors. (Davis, 1993)

Data Collection and Analysis

The preliminary study has been conducted in a primary school science course, in a topic of living things and non-living things, by the first author. Figure 1 illustrates the experimental method of this pilot study. As showed in the Figure 1, the science teacher, the first author, introduce a conceptual summary of living and non-living thing lesson to the students. Then, an introduction of how to play and learn with a proposed digital board game, shortly called Living or Not game, and its playing rules has been presented by the teacher. The students were allowed to interact with the game in group as multi-player approach and turn-based playing. Before ending the class, the teacher and students collaborated in a conclusion about the living and non-living things concepts by recalling what they received during the game and classifying them into living or non-living things. After completing the proposed lesson, all students took a post-interviewing to measure their perceptions for 10-15 minutes each.

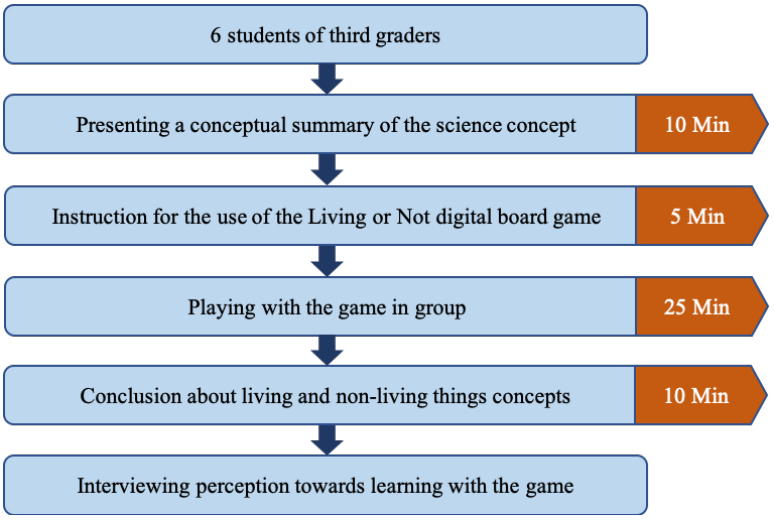

Figure 1. An illustration of the experimental procedure of this study
Game Design – Living things and Non-living Things

The design of the game is similar to the well-known snake-ladder game, which is a kind of common game made for board game and used by two or more players. Ladder snakes are interesting game that use dice to define how many steps a box has to go through. The researchers designed game attributes and its mechanics and rules following the snake ladder game for producing the Living or Not game. With the support of mobile technology, the Living or Not game is an interesting digital mobile game in a combination of board game, card game, and digital game by their nature.

For the Living or Not game, there are 30 scannable cards consisting of two types of cards: living things cards and non-living things cards. To begin the game, all players have to put their pieces in the starting position on the gameboard. Afterward, to get a card, the players have to roll the dice and go to a piece obtained. Then, the players can open a card as a piece picture obtained via the game, and the image on each card is connected with a specific mobile application for the game, which could be scanned and see the selected things by this mobile application, on mobile device's screen which this research used IPAD device. The board of the game consists of 30 boxes inside. There are many pictures of cards about living and non-living things in the boxes. Moreover, there is a conceptual question for each card displaying after the user scanning by mobile application. If the players answer correctly, a reward would be presented on the mobile application. On the other hand, if the player answers wrongly, a punishment would also be presented as well. Figure 2 shows an example of gaming steps by using the digital board game.

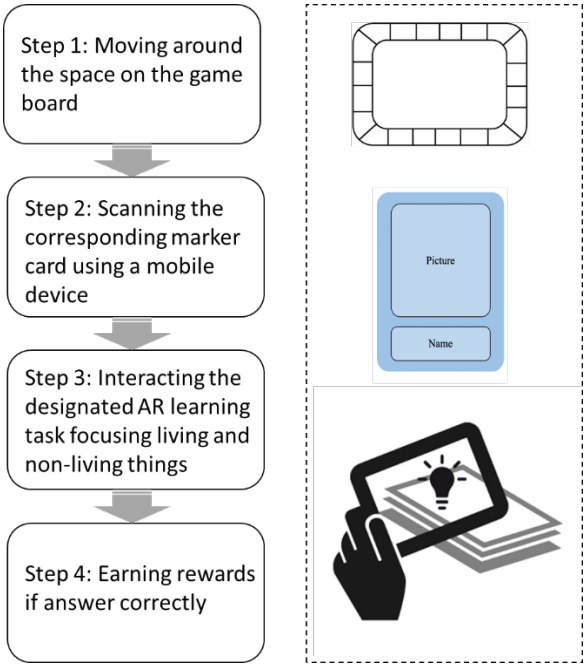

Figure 2. An illustration of gaming steps with the living thing or not digital board game

The content in the *Living or Not* game is about the theme of living things and non-living things. The board game development is focused on playing about the characteristics of living and non-living things. As such, players would learn to know different characteristics and how to classify a type of living and non-living things as the contained in each card. In the game, there are seven characteristics; growing, reproduction, breathing, eating, moving, responding, excretion. The game step is performed by the player in turn until one of the players successfully place on the last box and say the word "Finish", or the teacher limited the timing to play with the game. Figure 3 of a learning process by using digital board game.

Furthermore, the *Living or Not* game has been designed for students in multi-player style and turn-based task. Therefore, they can play it in groups or individuals in the classroom or even playing with their parents at home.

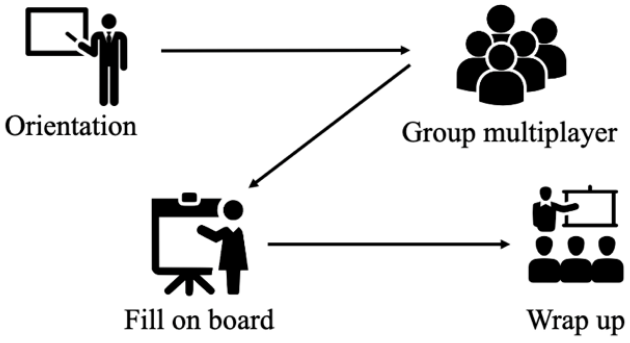

Figure 3. An illustration of learning process by using digital board game

4. Research Result and Discussion

This study purposes to examine primary school students' perception towards a supplemented digital board game in a science class. This study demonstrates its qualitative findings regarding the students' perception. Meanwhile, data that was collected qualitatively; more specifically interviews, were coded. Thus, the results of the study "S1" refers to "Student 1", "S6" stands for "Student 6", respectively.

Generally, these results show an important need for a digital board game in science learning. These results demonstrated that participants provided positive feedback when asked about their views on the use of a digital board game in their science learning. The students provided positive comments when asked about their views on the use of a digital board game in science learning.

From the view of Technology Acceptance Model (TAM), perceived ease of use, perceived usefulness, user satisfaction and attribute of usability are supposed to be related to using digital board game in science learning. Moreover, researchers adapted the TAM to consist of learning aspects and playing aspects after interacting with the digital board game. From table 1, the Item 1 about learning perspective, one of the students explained that "Yes, a game has information about the characteristics of living things. For example, a human can reproduction or evolution". The perspective was reflex by S1, S5, and S6 in which they felt that "I can know that what is living things or non-living thing". Item 2, the view was commented by S1, S2, S4, and S6, they believed that "Yes, it [digital board game] is useful. We can answer questions, for example, Can it move?, Can it reproduce? Can it excrete? and so on". Item 3, S2, S3, S5, and S6 noted that "It [digital board game] is easy because i can divide about characteristics of living and non-living things through IPAD". Item 4, all of students mentioned that "This game is good because it has knowledge". Item 5, one of the students alluded that "Sure, because i like to use a smartphone on learning". In the same way with S1, S2, S4, S5, and S6 mentioned that "I want to play a game again". The learning of living things and non-living things through digital board game learning environment supports to learn by themselves.

Table 1. *Perspective of Students' Perception with Digital Game Based Learning*

Items	Perspectives	Questions
1	Learning	Do you think a game could be a tool for learning science by yourself? Why or why not?
2		Do you think the game can support your learning about living things or non-living things? How?
3		Do you think it is easy to learn about living things or non-living things by using the game? How?
4		Does the game is good for your learning experience? How?

Items	Perspectives	Questions
5		If you need to learn about living things or non-living things, will you use the game? How?
6	Playing	Do you think a game could be a tool for playing science by yourself? Why or why not?
7		Do you think the game can support your playing about living things or non-living things? How?
8		Do you think it is easy to play about living things or non-living things by using the game? How?
9		Does the game is good for your playing experience? How?
10		Do you think it is a tool that can use to play the game? How to play?

For the playing perspective after interacting digital board game, these results showed Item 6, "Yes, I can because it [digital board game] enjoys because we can think and see a card by ourselves through the iPad" as mentioned by S1, S3, S4, and S6. For item 7, As S1, S2, S4, and S6, they believed that "This game has useful because we can play and learn together". The view of item 8 was echoed by S1, S3, S4, S5, and S6 in which they felt that Student A "It [digital board game] is easy to play because we just roll the dice and use the iPad to play a game". S5 referred that "It [digital board game] is very good because it [digital board game] is enjoyable and easy to play." for the view of item 9. For the last item, S2, and S5 noted that "Yes, i can play with my younger brother. I can teach him how to play a game."

This qualitative study was shown students' perception of digital game-based learning using the Technology Acceptance Model. This study also found that students perceived digital board game as fun and interactive tool. In addition, digital board game can be played at spare time, play with family or friend, review science content after the learn finished and makes learning a fun process. Related to a previous study indicated that the participants mentioned that digital learning can promote the experience more enjoyable and interesting (Mora, Loreto, & Divitini, 2016). Similarly, Chik (2014) demonstrated that playing a game with other communities of players could extend students' vocabulary and enhance students' language skills. Furthermore, by developing the digital board game, the game is improved with several visual and sound which makes it a good educational tool that promotes pleasure, enjoyment, and motivation of students (Sahrir, Zainuddin, & Nasir, 2016). These finding could use to refine on digital game-based lesson that encourage better student learning.

5. Conclusion and Future Study

In this study, researchers purpose to investigate the perception of a digital board game among elementary students in science learning specifically in living things and non-living things. From the results, it seems clear that most students believed that digital board game could enhance their knowledge about living things and non-living things. They have positive perception to the digital game-based science learning with a board game. Based on the results of this study, it is presented that the digital board game has a great tool for support more innovative science classroom education method in 21st century. According to the preliminary findings, the researchers will design board game-based learning with appropriate pedagogy to promote students' learning performance in the next study.

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