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PAPER • OPEN ACCESS

Designing solar system material through science domino game and booklet

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Designing solar system material through science domino game and booklet

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Abstract. Teaching and learning activity of science lesson in elementary school is considered less interesting due to the use of monotonous and memorizing methods. Solar system is a common topic which taught by applying these methods. In order to anticipate boredom and monotony, supporting learning media which trains students to be active, creative, and have better understanding is required. This study aims to find out the role of science domino game and booklet in improving the sixth grade elementary school comprehension of students on basic concept of solar system topic and generating a learning trajectory on solar system topic. It used design research which consists of preliminary design, teaching experiment, and retrospective analysis. Therefore, it described how science domino game and booklet enhanced ability of students in grasping basic concept on solar system topic and how the learning media yielded a learning trajectory in learning activity on solar system topic. Interview, observation, and documentation were used to collect the data. Based on the results of research, researchers produce learning trajectory about the solar system that can be used in learning and increased comprehension concept of students about the solar system.

1. Introduction

Natural Sciences subject should allow students development and their understanding of themselves and the world around them; the development of concepts, skills and attitudes that promote zest for knowledge and discovery; and the development of understanding science as a means to solve real-life problems, including the technological character [1]. Due to important role of science, the success of natural science learning outcome achievement should be a main concern of educators. However, achieving the maximum learning outcomes is quite challenging as there are some problems in teaching and learning process which require serious concerns for examples; the use of traditional methodology and low ability of students.

The use of lecture method in transferring natural science topic is a common problem faced in natural science learning. Lecture method is boring for most of students. Therefore, they are not interested in discussing natural science topic. Another problem that require to be faced by educators is student low ability and understanding on natural science lesson. Natural science subject like solar system topic is usually difficult to understand by students. Hence, students have low understanding in natural science because they prefer memorizing to comprehending the subject given.



Applying a learning medium like game is one of effective learning strategies that can be used to improve students' understanding on natural sciences topic especially solar system. Game creates fun learning atmosphere, stimulate students' interest and enhance their comprehension concept. The indicator of comprehension concepts, namely retelling a concept, clarifying objects based on certain characteristics, providing examples of a concept, presenting the concept in various form, developing maximum and minimum requirements of a concept, using and choosing certain procedures, and applying concept or problem solving [2]. In this study, the researchers design natural science domino card game.

The domino set, sometimes called a deck or pack, consists of 28 dominoes, colloquially nicknamed bones, cards, tiles, stones, or spinners. A domino set is a generic gaming device, similar to playing cards or dice, in that a variety of games can be played with a set. Dominoes are very simple and basic gaming implements that are so versatile you can play virtually an unlimited number of games with them [3]. Natural science domino card game is a learning medium used for teaching solar system topic. Domino card is a popular card game. The circles in domino card is replaced with solar system topic. The rule of game is similar to common domino game. The utilization of learning media makes learners not to be bored; thus, they are more enthusiastic about learning [4].

Natural science domino card (NSDC) is used as evaluation medium as well. The use of it enables students to learn and play. Furthermore, it supports students to actively participate in learning and teaching activities. Students' active participation makes them easier to memorize the solar system topic completely. The natural science domino card includes short description of solar system topic related to solar system.

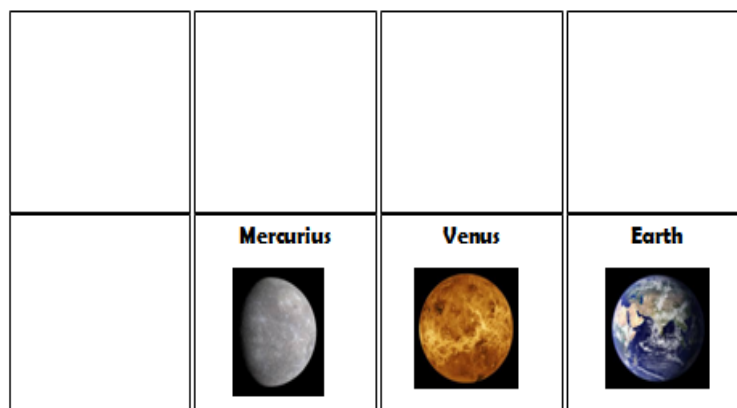


Figure 1. Natural Science Domino Card (NSDC).

Figure 1 shows natural science domino card in solar system topic. NSDC describes seven planets and their characteristics. Starting from the characteristic of Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

Astronomers who study the Solar System, known as planetary scientists, make use of robotic orbiters and landers that are sent directly to other worlds for more detailed measurements of these objects to supplement what we can learn about them from Earth-based or space-based (but still Earth-orbiting) telescopes. Planetary scientists are also able to investigate questions about the Solar System directly by analysing meteorites, including lunar and Martian meteorites, which can be studied in great detail in Earth-based laboratories [5].

Integrating NSDC into teaching strategies “forces” teachers to be creative in preparing learning media, such as; domino card pieces that must be relevant with teaching materials. In line with it, a study conducted by Nuraida, Kusumah and Kartasasmita in 2018 revealed the results of the analysis of the data shows that students based on Mathematical Prior Knowledge (MPK) acquire learning achievement have RME and LIT and enhancement strategic competence of the mathematical that are

higher than those of students who obtain the conventional learning [6]. In addition, a study conducted by Ozaki, Yamamoto and Kami in 2008 proved that integrating domino card into learning activities could maximize the development of students' mathematic knowledge [7]. Domino can help children to learn basic addition facts, domino can be used to achieve the purpose [8]. In contrast with the previous studies, this study generated learning trajectory about solar system, domino game and booklet used to enhance students' comprehension on solar system concept.

In this study, the researchers also design booklet of solar system topic. This booklet supports students to understand solar system topic completely. The booklet is small and thin and has not more than 30 pages. It includes descriptions and pictures of topics and covers introduction, content, and closing. The aim of this study is to produce a learning trajectory of solar system and improve students' comprehension on solar system concept.

2. Method

This study used design research method which is a part of qualitative approach. Design research aims to develop local instruction theory based on previous theory or empirical research through collaboration between researcher and teacher. The purpose of collaboration is to enhance the relevancy of research with educational policy and practice [9].

This research design defines a systematic analysis that designing, developing, and evaluating the intervention toward education (program, strategy, learning material, product, and system) as a solution to solve the complicated problems in education [10]. The cyclic occurs in design research. It is a repetitive activity from thinking experiment to learning experiment in diagram illustrating the experiment idea [11].

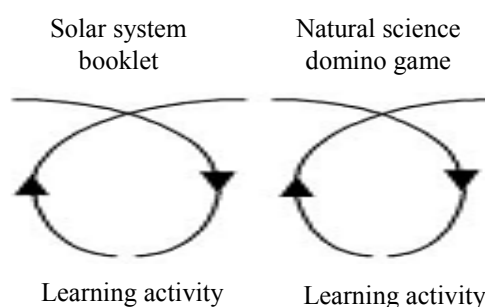


Figure 2. Learning activity in solar system topic

Figure 2 describes learning activity in solar system topic. It consists of two activities. They are learning solar system booklet and playing natural science domino game. The activities purpose to improve students' understanding concept.

Design research has some characteristics, namely interventionist; iterative; process oriented; utility oriented, usefulness of a design which is measured based on its practicality by user; and theory oriented [12]. Design research covers three phases, namely preparing for the experiment or preliminary design, the design experiment, and the retrospective analysis. Design research is related to Hypothetical Learning Trajectory (HLT) and Local Instruction Theory (LIT). The relationship between HLT and LIT can be described as a cycle, where LIT offers a plan trip and HLT is the itinerary for students [13].

In this study, the researchers use their knowledge on LIT to select appropriate learning activity and design HLT which is tried in the class of research participants. A theory which facilitates students to construct ideas and learning procedure is involved to develop LIT. a local instruction theory refers to "the description of, and rationale for, the envisioned learning route as it relates to a set of instructional activities for a specific topic" [14]. There are two important differences between an LIT and an HLT: (1) an HLT deals with a small number of instructional activities, while an LIT encompasses a whole

sequence; (2) HLTs are envisioned within the setting of a particular classroom, whereas an LIT comprises a framework, which informs the development of HLTs for particular instructional settings. Thus, the distinction between LIT and HLT is two-fold. One distinction is the duration of the learning process and the other is the situation in a particular classroom [15].

Figure 3 explains the theoretical background of research. It comprises pre activities, treatments, and post activities. Pre activities explain the background of the research. Treatments describe the activity in the research. Post activities show the result of the research.

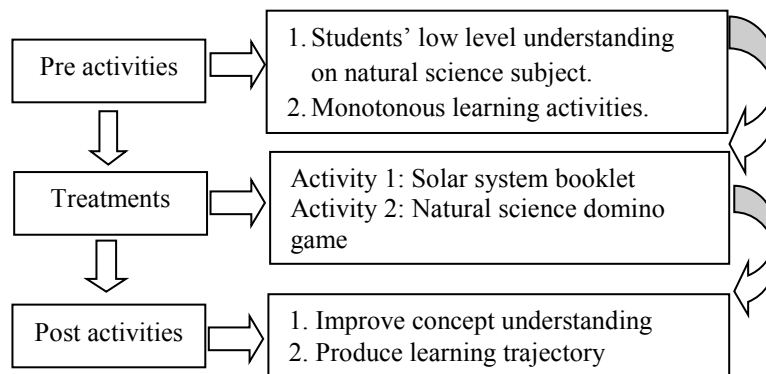


Figure 3. Theoretical background

This study was conducted in State Elementary School No.42 Palembang, Indonesia. The population of this study was all sixth grade students in 2017/2018 academic year. Grade VIA with 6 students was a pilot experiment class and grade VIB with 36 students was teaching experiment class. The data were collected through video record, observation, interview, and documentation.

3. Result and Discussion

3.1. Preparing for the experiment /preliminary design

This phase functions to implement the ideas from literature review regarding learning of trajectory material about solar system, curriculum, and design research as the basic formulation of students' preliminary strategic hypothesis in learning about solar system. Next step is the implementation of designing hypothetical learning trajectory (HLT) in natural science learning.

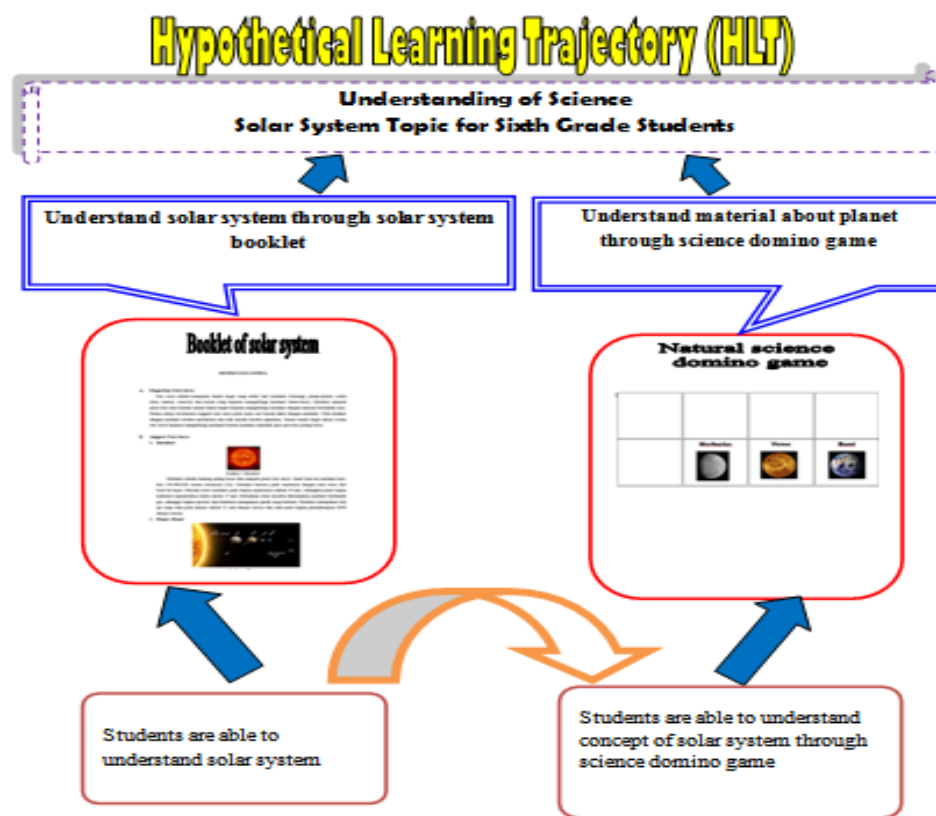


Figure 4. HLT of solar system topic.

Figure 4 describes HLT starting from booklet of solar system topic to natural science domino game. HLT shows the activities and the purposes of learning solar system topic. At the end of learning trajectory, the students understand natural science topic especially solar system. Theoretical background is synthesis about the relationship among variables which is arranged based on previously described theories.

3.2. The design of experiment

In this phase, researchers find out students with low, middle, and high level abilities. After that, the researchers conducted pilot experiment by using 6 students with different ability level. They are consisting of two low level students, 2 middle level students, and 2 high level students. They are doing two activities in this phase.

Two activities in pilot experiment class, namely: (1) first activities were using booklet of solar system and answering worksheet 1 to train students' understanding on solar system; (2) second activities were using natural science domino game and answering worksheet 2 to improve students' concept understanding on solar system topic.

Students' active participation in natural science domino game represented that students have understood the concept of solar system topic. Moreover, the activity of answering worksheet enables students to restate a concept, gives examples, and presents a concept in representation.

After conducting activities in pilot experiment class researchers continue activities in teaching experiment class. There are 36 students in the teaching experiment class. The first activities were using booklet of solar system topic and answering revised worksheet 1 which aims to make students understand solar system. The second activities were playing natural science domino game and answering student worksheet 2.



Figure 5. Students play natural science domino game.

Figure 5 shows students play natural science domino game in their group of experimental class. They play natural science domino game by using natural science domino card to improve their understanding on concept about planets and characteristics of planets.

Based on the results and discussions, it can be concluded that natural science domino design and booklet improved students understanding concept on solar system. It can be identified from the indicator of concept understanding. Learning by using science domino and booklet trains students to learn and play. Learning trajectory which generated from the study is very useful in learning solar system. In addition, this study will be beneficial for the teachers, students, school, and other researchers.

3.3. Retrospective analysis

This phase analyses the data from teaching experiment and the data result was used to plan the activity and develop the activity design of the next learning. Retrospective analysis aims at developing LIT. In this phase, the data obtained from the phase of Teaching experiment are analysed and the results of its analysis are used to plan activities and develop learning activities on the design of the next [16]. The aim of the analysis is to develop the retrospective LIT [17].

4. Conclusion

Based on the results and discussions, it can be concluded that science domino design and booklet improved students understanding concept on solar system. It can be identified from the indicator of concept understanding. Teaching and learning natural science by using natural science domino game and booklet of solar system trains students to learn and play. Learning trajectory which generated from the study is very useful in learning solar system. In addition, this study will be beneficial for the teachers, students, school, and other researchers.

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