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Game "STATIC": Is it effective for students' conceptual understanding?

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Game "STATIC": Is it effective for students' conceptual understanding?

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Abstract. The research aims to describe the effectiveness of game based learning in improving students' mathematics conceptual understanding. The game used in this research is called STATIC (Statistics in Arctic) which can be accessed using smartphone. The game was developed using the ADDIE model which consisted of 5 phases, analysis, design, development, implementation, and evaluation. The game has met the valid and practical aspects. The participants of this research were 33 students of 8th junior high school. The students' conceptual understanding is measured using multiple choice tests. The result showed that 76% of students have passed the Minimum Completeness Criteria scores in students' conceptual understanding test. It implies that the STATIC game could be used to improve students' conceptual understanding. Therefore it could be one of instructional media for teachers.

1. Introduction

Mathematics learning must be appropriate with current technological developments. So utilizing the progress of ITC as a facility, learning resource, and learning tool is important in learning mathematics. National Council of Teachers of Mathematics (NCTM) [1] revealed that technology is very important in teaching and learning mathematics, technology can improve student learning and influences the mathematics taught. Using technology in learning can stimulate effective student learning [2]. It can be said that current technological developments have provided great benefits for the mathematics education scope.

The importance of using technology in learning must also improve students' abilities in learning. Conceptual understanding is an important aspect in learning mathematics, it is one of the goal and a sign of success in learning. In addition, NCTM [1] also revealed that conceptual understanding is an important component of the knowledge needed to deal with non-routine problems. Meanwhile, the use of appropriate instructional media can improve students' mathematics conceptual understanding in learning [3].

Game based learning is one alternative media that can be facilitate mathematics learning [4] and it can improve students' mathematics conceptual understanding. Several smartphone games can be used as an instructional media that can facilitate students to learn in new and interesting ways [5]. However there are differences between game as instructional media and game as entertainment, such as differences in the quality of graphics and how they are applied, the purpose of the game and the types

of activities involved, the way the game is constructed, the time needed to play the game, and the collaboration and competition are integrated and designed a proper way [6]. In addition, Charsky [7] states that there are several things that need to be considered in developing games as instructional media, including competencies and goals to be achieved, regulations, choices presented, challenges, and fantasies in games.

Furthermore, game as instructional media must be integrated with the appropriate learning model. Problem based learning (PBL) is a learning model that can be used in mathematics learning. Students can learn through problems while actively involved with the PBL model [8]. Students are given the opportunity to solve problems in a collaborative environment and establish independent learning habits through practice and reflection. Reflection or question and answer is an essential part of the problem solving process in PBL. It is important for students to reflect on the knowledge and abilities acquired, the learning strategies used and contributions in group learning. In addition, they also summarized the concepts and understandings they gained [9]. Dolmans and Wilkerson [10] also suggest that PBL increases the recall of student concepts, student cognitive involvement, and student achievement.

Several studies have been conducted to see the effect of Game media on understanding students' mathematical concepts [11]. Kiili, Moeller, and Ninaus's [12] research found that game media can effectively improve students' conceptual knowledge in mathematics learning. Students can build mathematical concepts by completing game missions [13]. Chen and Rhen [14] also found that through the implementation of role play games the ability of students to understand mathematical material becomes better. RPG games can serve as an effective educational tool to motivate students and bring about learning performance. In addition, PBL models can also improve students' understanding of concepts. The ability of students to use concepts in real life has also been shown to increase [15].

Instructional media used in this research is STATIC (Statistics in Arctic) Game. The game is an android-based game to learn statistical material. The learning model used in the game is the PBL model. There are 5 syntaxes in the model, namely (1) Presentation of Problems; (2) Investigation Planning; (3) Investigation; (4) Presentation of Investigation Results; and (5) Reflection. The STATIC Game has fulfilled valid and practical criteria based on assessments of experts and users. It is expected that STATIC Game can help students more interested in learning and understanding mathematical concepts. The STATIC Game design can be seen in the figure below.
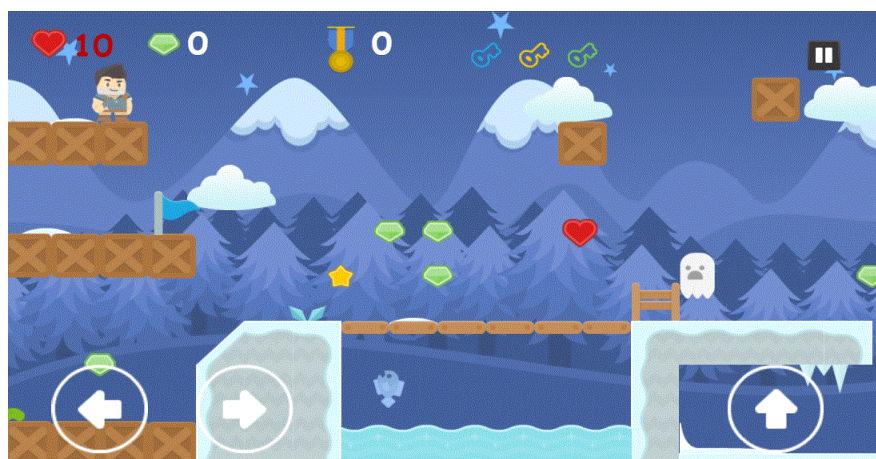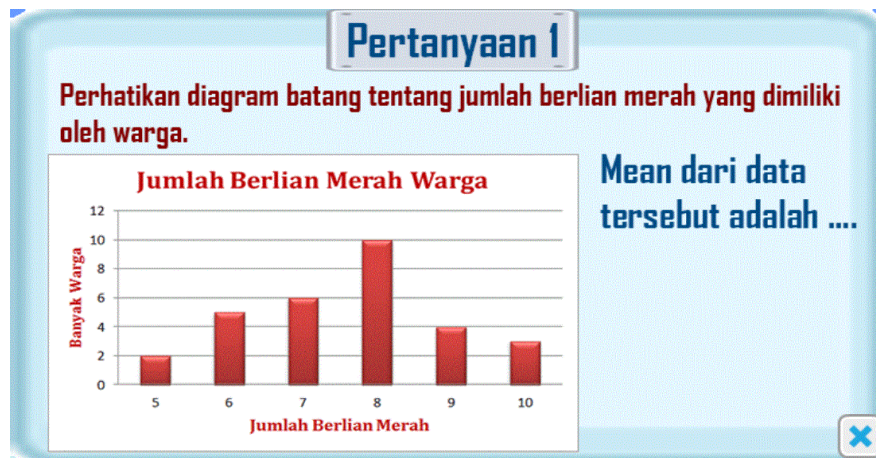

Figure 1. Stage in STATIC Game

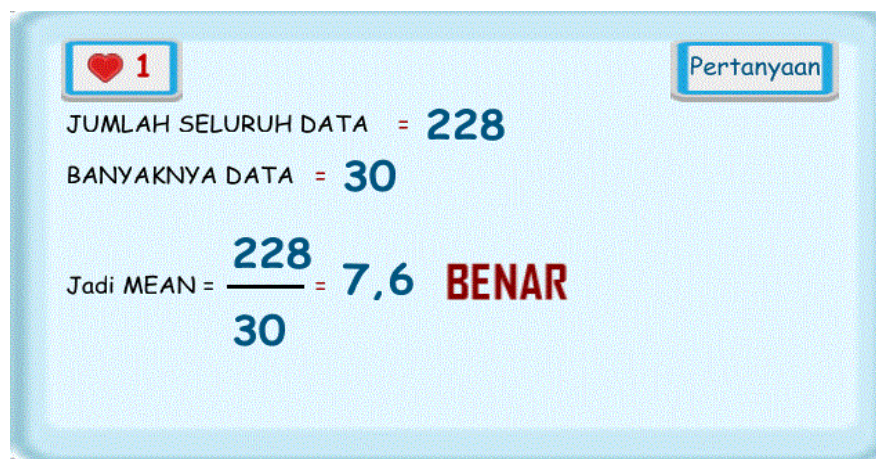**Figure 2.** Statistics Problems in STATIC Game

Figure 3. Answer Feedback in STATIC Game

2. Method

The development model uses the ADDIE model which consists of five main phases [16]; Analysis, Design, Development, Implementation, and Evaluation. The quality of STATIC Game was assessed by its validity, practicality, and effectiveness. One of the criteria for the effectiveness of instructional media in this research is that a minimum of 75% of overall students achieved Minimum Completeness Criteria scores. The Minimum Completeness Criteria scores of students in this research is 75.

Thirty three students of grade 8th were enrolled in this research. The participants included 13 male and 20 female from Junior High School in Yogyakarta area were selected using purposive sampling. Students are already familiar to using smartphones, so there is no difficulty in playing the STATIC Game. In addition, the school where this research conducted was a school that allows students to use smartphones as instructional media in the classroom.

Class treatment was conducted in class five lessons. Classroom learning is done using the STATIC Game that features statistical material. The concept understanding test instrument was used to measure the effectiveness of STATIC Game to improve students' conceptual understanding. The students' conceptual understanding test was given twice, pre-test and post-test. Pre-test is given before students use STATIC Game and post-tets is given after treatment. Pre-test and post-test contained 15 statistics problem in multiple choice questions, with each question containing 4 multiple choices. The results of students' mathematical concepts understanding tests are used as a measure of the effectiveness of instructional media. The indicators contained in the understanding of concepts include: (1) restating a

concept; (2) provide examples and not examples of concepts; (3) connecting between related concepts; (4) presents concepts in various forms of representation; and (5) applying the concept.

3. Result and Discussion

The goal of the research was to find out the effectiveness of the developed education game in regards to students' conceptual understanding. After obtaining data, effectiveness of the products developed can be known. Data of students' conceptual understanding results were used to find out how effective the STATIC Game as instructional media. The effectiveness of the STATIC Game can be seen from the percentage of the number of students who reach the Minimum Completeness Criteria scores of at least 75%. Based on the analysis of students' understanding of the data concepts, it was found that the STATIC Game met the effective criteria. The results of the pre-test and post-test understanding of students' concepts can be seen in Table 1.

Table 1. The Result of Test Students' Conceptual Understanding in Statistics Material

Description	Pre-test	Post-test
Maximum Score	80	100
Minimum Score	20	53,33
Mean	49,5	84,24
Students Achieved Minimum Completeness Criteria Scores	2	25
Percentage	6%	76%

Based on Table 1, it can be seen that the students' conceptual understanding before treatment is low and after treatment the mean of students' posttest is 84.24. In addition, the percentage of students who achieved the Minimum Completeness Criteria is 76% or 25 students from 33 students. Therefore it can be concluded that STATIC Game is effective based on the results of students' mathematics conceptual understanding tests.

The STATIC Game can be effectively used as an instructional media because it allows students to be actively involved in learning activities. Besides that, through STATIC Game students build understanding of their concepts by answering various questions given. Students also get feedback when answering true or false to help understand the material presented.

Chen and Ren [14] revealed the reasons for the effectiveness of educational games in stimulating learning related to science, technology and mathematics are as follows: (1) the use of games allows students to have a high level of control and activeness; (2) the use of games allows students to know their progress and give them immediate and immediate feedback; and (3) games provide learning scaffolding and help students progress through supported exploration.

The results showed that the STATIC Game helped students to improve their understanding of mathematical concepts. Instructional media with STATIC Game can facilitate student learning in understanding material such as in general classrooms. The material in the STATIC Game is presented in full and coherent so that students can understand the concept of statistical material in the media. Admiraal et al. [17] revealed that through learning experiences using games, students can understand the concepts of the material being studied. Furthermore, game education technology provides new opportunities for students to gain knowledge in interesting ways, enabling students trained with different abilities to obtain information equivalent to students using traditional learning [18].

The PBL model presented in the STATIC Game also plays an important role in learning. PBL models allow students to understand the concepts of the subject matter and students can learn effectively [8]. Padmavathy and Mareesh [15] also stated a similar thing that PBL models influence mathematics learning and improve student understanding, as well as the ability to use concepts in real life. The PBL model in the STATIC Game has the characteristic of using problems in real life to build student knowledge. Learning by using real problems and then students learn to find solutions to these problems can help students in understanding mathematical concepts [19],[20].

The STATIC Game also facilitates students to work together in building knowledge through discussion activities. Students discuss with classmates to solve various problems given in STATIC Game. Discussion activities in the PBL model enable students to involve themselves in the formulation and verification of concepts and help students conceptualize mathematical activities [21].

4. Conclusion and Future Work

The STATIC Game based on the Problem Based Learning model can be used as an instructional media as it helps students to understand the mathematical concept. It could facilitate students to understand mathematical concepts in new and interesting ways. The game also can be used as reference material by the teacher and further research. However, STATIC is only limited to statistical material for grade 8th junior high school. There is a need to develop game based learning media on other mathematics material and can be combined with other learning models. Further studies are needed as game based learning media might also facilitate students to improve their abilities in various aspects of learning.

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