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THE DEVELOPMENT OF SMART CIRCUIT MEDIA TO IMPROVE THE STUDENT OUTCOME IN MATHEMATICS LEARNING

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Abstract: Smart circuits are learning media to be applied in Mathematics learning. This study aims to find out the development process, feasibility, and influence of smart circuit media in mathematics learning for third grade in Elementary School. This study used the Research and Development research method, with the Borg, and Gall model. The development begins with determining the core competencies, basic competencies, indicators and subjects for making questions. The researcher put stickers of interesting cartoon images on each plot on the wooden planks of this medium. The necessary media prerequisites include: dice, pawns, game hints, and a memory. After the media is made, a feasibility test analysis was done, before the t-test. The data collection instruments used questionnaires, observations, and interviews. The results of this study showed that: (1) The smart circuit media is feasible to implemented in improving mathematics learning outcomes. This can be seen from the results of feasibility test by media experts and material experts before it is implemented in the class which showed that the presentation aspect gets a percentage of 82.5% from the first media experts, and 90% from the second media experts; efficiency aspects was 81.25%, and 100%; and media quality aspects was 82.5% and 92.5%. (2) Based on the t-test result, it can be concluded that the smart circuit media can improve student learning outcomes. This is showed by the significant difference in learning outcomes between the experimental class, and the control class with a significance value of 0.014 < 0.05. The impact of this research is the students can understand the material in learning mathematics easily.

Keywords: Media Development, Smart Circuit Media, Learning Outcomes

PENGEMBANGAN MEDIA SIRKUIT PINTAR UNTUK MENINGKATKAN HASIL BELAJAR SISWA PADA PEMBELAJARAN MATEMATIKA

Abstrak: Sirkuit pintar adalah media pembelajaran yang menarik untuk diterapkan dalam pembelajaran Matematika. Penelitian ini bertujuan untuk mengetahui proses pengembangan, kelayakan, serta pengaruh media sirkuit pintar dalam pembelajaran matematika kelas III MI. Penelitian ini menggunakan metode penelitian *Research and Development*, dengan model Borg, and Gall. Pengembangannya dimulai dengan menentukan kompetensi inti, kompetensi dasar, indikator serta mata pelajaran untuk membuat pertanyaan. Peneliti menempelkan stiker gambar kartun yang menarik di setiap petak pada papan kayu media ini. Prasyarat media yang diperlukan antara lain: dadu, bidak, petunjuk permainan, dan bengkel ingatan. Setelah media dibuat,

selanjutnya dilakukan analisis uji kelayakan, sebelum dilakukan uji-t. Instrumen pengumpulan data yang digunakan antara lain kuesioner, observasi, dan wawancara. Hasil penelitian ini menunjukkan bahwa: (1) Media sirkuit pintar ini layak digunakan dalam meningkatkan hasil belajar matematika. Hal ini dapat dilihat dari hasil uji kelayakan oleh ahli media, dan ahli materi sebelum diterapkan di lapangan yang menunjukkan bahwa aspek penyajian mendapatkan persentase sebesar 82.5% ahli media pertama, dan 90% dari ahli media kedua; aspek efisiensi sebesar 81.25%, dan 100%; serta aspek kualitas media sebesar 82.5%, dan 92.5%. (2) Setelah dilakukan uji-t, dapat disimpulkan bahwa media sirkuit pintar dapat meningkatkan hasil belajar peserta didik. Hal ini dibuktikan dengan adanya perbedaan hasil belajar yang signifikan antara kelas eksperimen, dan kelas kontrol dengan nilai signifikansi 0,014 < 0,05. Dampak penelitian ini adalah peserta didik dapat memahami materi pada pembelajaran matematika dengan mudah.

Kata Kunci: Pengembangan Media, Media Sirkuit Pintar, Hasil Belajar

INTRUDUCTION

The elementary school age is belong to the concrete period of children development, because the characteristics of this period is being able to understand concrete things (Sultan Qaimuddin Kendari, 2013). Mathematics is one of the basic sciences which has an important role in the effort to master science and technology today. Many view mathematics as an abstract, theoretical science, full of complicated and confusing symbols and formulas.(Hidayat, Vivi Yandhari, & Alamsyah, 2020) However, mathematics subjects are often seen as boring and frightening lessons by every student because it is not uncommon for teachers to provide learning where students are still required to think abstractly, there is no opportunity for students to be idealistic, and practice or students directly play a role in the learning process less active (Yeni, 2015).

Mathematics is an important knowledge that is always used in every aspect of life. Mathematics lessons are always given at every level of education. According to Suryani et al, mathematics needs to be given to students starting from elementary school to equip students with the ability to think logically, analytically, systematically, critically, and creatively, as well as the ability to work together (Suryani, Setiawan, & Putria, 2018). Some experts define the meaning of mathematics differently, but in principle have the same meaning. According to Suwangsih, based on the origin of the word taken from Greek literature, namely mathematics, mathematics means knowledge gained by thinking (reasoning) (Isnawan & Wicaksono, 2018). That is the hallmark of mathematics, although other subjects also need reasoning, mathematics is an exact science that requires reasoning to seek certainty and truth.

Based of the observation, the students can not be separated from learning activities that give experience by everyone. Knowledge, skills, habits, hobbies, and attitudes, a person is formed and developed because of the learning process. Someone is said to learn when it is assumed that in that person there is a process of activity that results in a change in behavior (Ningrum, 2016). The change in behavior in question is what has not previously been understood becomes understood and what has not been true has become true. As in learning mathematics, which initially did not understand how to do it, learn to understand how to do or find solutions to these problems.

Mathematics learning that given at every level of education, including elementary school. However, at the elementary school level, mathematics lessons are still given in basic form. According to Permendiknas No.22 which contains content standards for mathematics objectives, it is stated that learning mathematics in Elementary School has a scope that includes aspects, namely numbers, geometry and measurement, as well as word processing.

Elementary school students are on average aged 7-11 years. The children at that age stage are still at the concrete operational stage. At this stage the child is able to think concretely as it is, able to conserve numbers, and understand concepts through their own experiences. However, to understand these mathematical concepts, children still need concrete objects. Therefore it is very appropriate if learning mathematics uses teaching aids or media to help explain abstract things to be concrete.

Mathematics is expressed by Ruseffendi which reveals that every concept or principle in mathematics that is presented in a concrete form will be well understood. This means that objects or objects in the form of games will play a very important role if they are properly manipulated in teaching mathematics (Russefendi, 2006). Agusman argues that the concepts in the elementary / elementary mathematics curriculum can be divided into three major groups, namely instilling basic concepts (instilling concepts), understanding concepts, and developing skills (Agusman, 2017).

The use of instructional media in elementary schools that will be used in this research is very important, because sometimes they have used the media to explain or reinforce the material but they are not fully functional because they are classical and visual. So that students observe and see the media together which causes boredom or students are less interested in the material to be delivered (Subaidi, 2016). So it is necessary to develop media that can be made more meaningful and varied in order to attract the attention of students. Based on the observation by the researcher, the teachers who create something new, creative and innovate, especially at media can deliver the subject, and lesson to the student very will. Choosing the right learning media for students, is depend to the characteristics of students. As teachers, they must pay attention to this, so that the use of media really hits the students and is in accordance with the circumstances or conditions.

One of instructional media that can be developed to mathematic learning was smart circuit media learning. This media is a combination of chess and snakes and ladders, the design of the board appearance is like a chessboard that can be used as a container for smart circuit game equipment. While the gameplay is similar to a snake and ladder. The concept of this game is played by two or more children by rolling the dice and walking through the boxes with pictures on them (Afandi, 2015). From his book Yasin said that the mathematics circuit media was developed by an teacher named Auliya in 2009 and won first place in the national level learning media competition in 2009 which was organized by the Ministry of National Education (Yasin & Auliya, 2011).

Smart circuits consist of English circuits and mathematical circuits which basically the idea is still in one game, namely the game of snakes and ladders. According to Yasin, this media was created based on the many problems encountered in student learning, namely the number that must be understood and remembered by students, the demand for good grades. Many students have difficulty in mathematics and English, and students who prefer to play (Rahayu, AR, & Deskoni, 2019). The problems stated by Yusuf are the same as for students at MI Plus Al Istighotsah, so that they can

be used as a basis for choosing a game media developed to convey learning to students. This can be considered due to the learning characteristics of elementary school children at this time, namely: (1) starting to think critically, (2) starting to appear competition between friends, (3) having a deep curiosity, (4) like to ask questions, and (5) like groups (Chabib, Tri Djatmika, & Kuswandi, 2017). This smart circuit media is very suitable for children at elementary school age.

The smart circuit media in mathematics learning has advantages, including: a) The media is designed in a colorful manner and there are many cartoon images that can attract the attention of students, b) The existence of an image design can reduce the tension or seriousness of students, c) This smart circuit media not easily damaged can be used more than once, d) Provide motivation indirectly to students, e) In playing smart circuit media also train children to be honest, patient and responsible, f) Strengthen memory about angular material, g) Improve results learn. Wati in her book argues that the media is something that transmits messages and can stimulate the thoughts, feelings, and willingness of the audience so that it can encourage the learning process in themselves. Creative use of media will allow the audience to learn better and can improve their performance according to the goals to be achieved (Wati, 2016). This is supported by the Behavioristic theory put forward by Pavlov that every stimulus or stimulus will cause a reciprocal motion or response.

The similar research was done by Tanir by the using of smart board in German Language Teaching, as the result of this research it can be well approved that smart-board usage is a constructive way of learning by the Academicians (Tanır, 2015). Hidayati, and Wuryandri also conducted the research about the important of learning media, by the study that they do, but this research done in Junior High School grade (Hidayati & Wuryandari, 2012). Turkay et al also conducted a study entitled "Collectible Card Games as Learning Tools". This study present powerful aspects of collectible card games (CCGs), and what these media might bring to a learning ecology by examining the creativity, cognition, logical reasoning, and develop skills that might be difficult to teach in a classroom setting. (Turkay, Adinolf, & Tirthali, 2012). Routarine, and Ylirisku also made a study about the implementation of learning media by using Video Card Game as a Learning Design for Teacher Education (Routarinne & Ylirisku, 2012). Based on the previous studies above, the researcher would like to conduct a study entitled "The Development of Smart Circuit Media to Improve The Student Outcome in Mathematics Learning"

METHODS

This study used research and development method to produce certain products that implemented in education field (Sugiyono, 2019). Borg and Gall used the term Research and Development which is defined as a process or method used to validate and develop products. These developments can take the form of updating existing products to make them more practical, influenceive, and efficient, or actually creating new products that were not there before (Gall & Borg, 1989). This research will use 7 stages only from 10 stages of Borg and Gall's research and development steps, namely research and data collection, planning, development of initial product formats, product validation, revision of product validation results, small-scale field trials, and revision of product results, field trials.

The development procedure is an explanation of the prefind outd development model. The steps taken in the Borg and Gall development procedure include:

1. Trial Design

This activity begins with collecting data and testing the feasibility of the product by means of validation by several experts. Test the feasibility of the product by giving a questionnaire to the validator to assess the level of validity, as well as the practicality of the product being developed, as well as due diligence on the target product use.

2. Subject Trial

The trial subjects consisted of experts in the field of media, experts in the field of materials, as well as product use targets (Third grade at MI Plus Al Istighotsah Pangungrejo Tulungagung).

3. Types of Data

The type of data used is quantitative data and qualitative data. Quantitative data is data in the form of numbers (Arifin, 2017), while qualitative data is data related to categorization, characteristics in the form of questions and statements in the form of words (Riduwan, 2015). Quantitative data were obtained from preliminary research in the form of observations and data from small group tests and field tests. Qualitative data were obtained from various expert / validator reviews.

a. Data Collection Instruments

This study used several data collection instruments to find out how far the success of the product developed is including test, observation, questionaires, and interview. Test in this research used to measure the learning outcome of students. The observation in this research used to certain the activities done by the students with that media, while the questionnaires, and interviews was done with the expert of subject learning and media learning.

b. Data Analysis Techniques

The data analysis technique applied in this research and development is quantitative data analysis which begins with a feasibility analysis. The research data on the feasibility of development of smart circuit media in mathematics learning will be analyzed descriptively. The formula for processing percentage descriptive data is as follows:

$$V = \frac{TSe}{TSh} \text{ x } 100\%$$

Note:

V : Validity

TSe: empiric score

TSh: maximal score

Validation is done to try out products that have been revised in instruction practices. Validation focuses on product applicability, namely whether the product can be used or not (Widoyoko, 2012).

Table
The Feasibility Presentation of Product

No	Criteria	Feasibility Level
1	81,00%-100,00%	Very feasibility
2	61,00%-80,00%	Feasibility
3	41,00%-60,00%	Less Feasibility
4	21,00%-40,00%	Not Feasibility

5	00,00%-20,00%	Very not Feasibility

After going through this feasibility analysis stage, the researcher then continued testing the influenceiveness analysis consisting of validity tests, reliability tests, then the Researcher also went through the homogeneity, normality test stages, and finally the t test, to find out the influence of using the module.

Before conducting the test using the t-test, the researcher must perform a prerequisite test which includes a homogeneity test and a normality test so that the available data can actually be analyzed by the t-test. The smart circuit media that has been revised based on suggestions from experts, then tested in the field. Field trials were conducted at MI Plus Al Istighotsah by taking class 3A as the experimental class and class 3B as the control class. Homogeneity test was performed using SPSS 20.00 for Windows. From the homogeneity test that the Researcher conducted, it is known that the significance value of the Test of Homogeneity of Variances is 0.636> 0.05. So it can be concluded that the data is homogeneous, so it is suitable for use in research.

After the homogeneity test was carried out, the researcher then carried out the normality test. The normality test is carried out to find out whether the data used is normally distributed or not. If the data is not normally distributed, then the test cannot be continued to the next stage. The normality test was performed using the I-Sample Kolmogorov Smirnov. In this test, the data is said to be normally distributed if the significance level is ≥ 0.05. If the data has a significance level of <0.05, the data is said to be not normally distributed. The data used to test for normality is the result of students' post-test scores. From the normality test that the Researcher conducted, it is known that the significance value of the I-sample Kolmogorov Smirnof test in the experimental class is 0.836> 0.05 and the significance value in the control class is 0.864> 0.05. So, it can be concluded that the data from the two classes are normally distributed.

RESULT AND DISCUSSION

Result

The Development of Smart Circuit Media to Improve the Student Outcome in Mathematics Learning

The development of this smart circuit media begins with conducting research and collecting data in the field. Research and data collection are needed to find out the location of the study, the material to be used and to analyze the needs used as the basis for the preparation of the product being developed. Furthermore, at the planning stage the researcher begins to find out the design, content (core competencies, basic competencies, and indicators), the overall media display design starting from the form of the board to the pieces so that it fits the material and also makes it look attractive to students so they can be motivated.

The product draft development stage begins by describing the basic competencies into indicators that will later be used as a reference in designing images so that they match the material and learning objectives. The image was designed in Photoshop version 2.0 and then printed on 300 grams of paper to make it durable. Images are pasted on a board similar to a chessboard. Researcher used a board similar to a chessboard to make it easy to place the smart circuit media equipment, such as: toy pieces, dice, memory workshop, and game instructions.

Picture 1. Smart Circuit Board and the Instructions of It

The smart circuit board is decorated with cartoon stickers to make it look attractive. Dice made of wood are intended so that the dice are not easily damaged. Wooden dice are affixed with a sticker that says the type of corner name with a cartoon image added to make it more interesting. Making memory workshops and researcher game instructions using Microsoft Word to make it easier in the manufacturing process. Researcher made two forms of game instructions, namely the form of cards used as reference for students in playing smart circuit media and in the form of a more complete book, which could be used as a reference for teachers in the learning process with smart circuit media.

The Feasibility Test of Smart Circuit Media to Improve the Student Outcome in Mathematics Learning

The feasibility of smart circuit media in this study is based on the validation results from media experts and material experts. Based on the validity test results of the first media expert, the presentation aspect got a percentage of 82.5% (very valid) and 90% (very valid) from the second media expert. Furthermore, for the aspect of efficiency, the first media expert gave a percentage of 81.25% (very valid) and the second media expert gave a percentage of 100% (very valid). The media quality aspect got a percentage of 82.5% (very valid) from the first media expert and 92.5% (very valid) from the second media expert. The table of these results as follow:

No.	Media Aspect	First Validator	Second Validator
1.	The presentation	82.5%	90%
2.	The efficiency	81.25%	100%
3.	The media quality	82.5%	92.5%

The second media expert suggested adding a cartoon image to each tile on the board and on each side of the die. It is also recommended that the researcher adds cartoon stickers to the edges of the board so that it doesn't look plain. In addition, he advised to replace pawns that are not easy to move on their own, so that students are not disturbed. This is in accordance with the nature of the game which is challenging,

addictive and fun can have a positive impact if the games played are educational (Ningrum, 2016).

Then, based on the results of material testing from material experts, the relevance aspect gets a percentage of 80% (very valid) from the first material expert and a percentage of 95% (very valid) from the second material expert. The presentation systematic aspect got a percentage of 84.38% (very valid) from the first material expert and a percentage of 93.75% (very valid) from the second material expert. Whereas in the aspect of the presentation of learning, it got a percentage of 85.71% (very valid) from the first material expert and a percentage of 92.86% (very valid) from the second material expert.

No.	Material Aspect	First Validator	Second Validator
1.	The relevance	80%	95%
2.	The systematic	84.38%	93.75%
3.	The presentation	85.71%	92.86%

The second material expert gave a suggestion to change some of the pictures in the grid to really fit the material which is about the angles. An angle is an area created by two intersecting lines around the intersection point. According to the second material expert, there are several pictures that do not meet between the two lines. There are some pictures that are not clear enough, giving rise to a double interpretation. So he suggested replacing a clear and precise image. In accordance with Bruner in Yusuf, at the age of elementary school, to get the ability to grasp including memory, understanding, and application still requires eyes and hands (Yasin & Auliya, 2011). So that the image display on the material must be really appropriate and precise so that students do not misunderstand.

The researcher made revisions according to the advice of the second material expert before using the media in the field. Based on this data, the product developed can be said to be feasible to be applied in the learning process. So that the smart circuit media can be used in the learning process with revisions in some parts.

The Influence of Smart Circuit Media to Improve the Student Outcome in Mathematics Learning

After conducting the homogeneity and normality test of the data, the researcher used the Independent Sample T-test (t-test) to test the significance of the difference between the two means from the two distributions. The t-test was performed using calculations using SPSS 20.0 for Windows with the following output results:

Table

The results of the Independent Sample T-test output

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper

Hasil Belajar Siswa	Equal variances assumed	5,260	0,028	2,572	37	,014	11,237	4,368	2,386	20,087
	Equal variances not assumed			2,605	31,195	,014	11,237	4,313	2,442	20,032

The significance is 0.014 <0.05. So, it can be concluded that there are differences in learning outcomes between the control class (carrying out the learning process without smart circuit media) and the experimental class (carrying out the learning process using smart circuit media).

As in this study, which uses two classes, one using smart circuit media and one not using, and it turns out that after being tested using the T test there is a significant difference in learning outcomes. If the motivation to learn can be raised, the teacher's job is to maintain that motivation until the end of the lesson, so that learning outcomes can be improved. Based on the explanation above, it can be concluded that, there are differences in learning outcomes between the control class (learning process without using smart circuit media) and the experimental class (the learning process uses smart circuit media). Students in the experimental class feel happy and motivated when learning to use smart circuit media. So that the average of their learning outcomes is higher than the learning outcomes of students in the control class.

Discussion

This study aims to develop learning media in the form of smart circuits in mathematics learning. The research was conducted using the Research and Development method with Borg and Gall's research steps. The researcher suffers from the research process in the seventh step due to limited time, energy, and cost. The selection of smart circuit media is based on the importance of a fun learning process through games. The fun of elementary school students is at the game stage. Through games students can formulate an understanding of a concept, rules, main elements, processes, results, impacts and so on (Gusranda, 2018).

The development of this study is based on visual learning media in the form of smart circuit media for Mathematics learning for grade III at Islamic Elementary School. Each visual presentation consists of a number of elements which are deliberately arranged. There are at least 3 main categories of visual design elements, namely: visual, text, and affective elements. a) The visual elements include: graphics, symbols, real objects, or visual organization. b) The text elements include: all aspects of textual presentation, from the choice of words to the style of shape, color and size used. c) The affective elements, including: visual components that can elicit responses from observers such as fun, amazement, humor and so on (Suryani et al., 2018). These three references must be considered in the process of developing visual-based media so that the media being developed is easy and feasible to use.

Nurlaili explained that playing is an activity carried out with or without using tools, which generate understanding or provide information, provide pleasure or develop children's imagination (Nurlaili, 2018). So, they can learn without leaving their instincts who still like to play, and on the contrary, they can fulfill their instincts to play without leaving their education. The smart circuits combined with various interesting pictures and colors can help increase students' motivation and interest in learning. According to Wati, the purpose of adding images to learning media is to visualize the concepts that

students want to teach (Wati, 2016). The existence of questions accompanied by pictures will help students analyze the desired answers. This is in line with several theories and research results in the journal Valiant which prove that learning outcomes are influenced by several things including the motivation of students (Sutrisno & Siswanto, 2016). Meanwhile, the motivation of students can be grown through what they like and anything interesting according to their age level. One of them is the media used in the learning process.

The novelty of this study, in terms of learning media, is if students' activeness in learning using smart circuit media increases, their learning outcomes will increase. This activity process can be observed from the range of their involvement during the learning process. Based on the research results that conducted by the researccher, it can be concluded that the smart circuit media has a positive and significant effect due to improve the student learning outcomes in Mathematic Subjectat Islamic Elementary School, and increases the activeness in the learning process.

CONCLUSION

The development of this smart circuit media starts with finding out the core competencies, basic competencies, indicators and subjects used. used as a reference in making questions and pictures by adding an interesting cartoon image in each square in the smart circuit game. Researcher put stickers on a wooden board that can be used as a container for media equipment: dice, pieces from toy cars, game instructions and memory workshops. This smart circuit media is suitable for use in improving mathematics learning outcomes. This can be seen from the results of due diligence by media experts and material experts before being applied in the field. Smart circuit media can improve learning outcomes as evidenced by a significant difference in learning outcomes between the experimental class and the control class with the t-test result data where a significance value of 0.014 <0.05 is obtained.

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