

Development of Math Set Game to Improve Critical Thinking Skills Student of Class VII Material Set

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ABSTRACT

This research is a type of Research and Development (R&D) research that tests the validity, practicality, and effectiveness of Math Set Game media. Math Set Game media is a medium developed in the learning of students of mathematical set materials and one of the digital learning media by utilizing RPG Maker MV media as the basic system in its development. The development model used in this research is the ADDIE development model, which consists of Analysis, Design, Development, Implementation, and Evaluation. The data obtained from this study is quantitative data obtained from the results of expert review materials, the results of media expert reviews, student response results, and the results of critical thinking skills tests of students as many as 30 people. The data collection technique used is a) validation; b) questionnaire; and c) the critical thinking capability test with the instrument used is a) validation sheet; b) response questionnaire sheet; and c) critical thinking ability test sheet. Based on the research that has been carried out, data has been obtained that shows that math set game media is valid, practical and effective in improving the critical thinking skills of students set materials so that math set game is worth using in learning and can be disseminated for educational purposes.

Keywords: Role Playing Game, Game Education, Math Set

ABSTRAK

Penelitian ini merupakan jenis penelitian *Research and Development (R&D)* yang menguji tentang kevalidan, kepraktisan, dan keefektifan media Math Set Game. Media Math Set Game adalah media yang dikembangkan dalam pembelajaran siswa materi himpunan matematika dan salah satu media pembelajaran digital dengan memanfaatkan media RPG Maker MV sebagai sistem dasar dalam pengembangannya. Model pengembangan yang digunakan dalam penelitian ini adalah model pengembangan ADDIE, yang terdiri dari *Analysis, Design, Development, Implementation, dan Evaluation*. Data yang diperoleh dari penelitian ini adalah data kuantitatif dimana diperoleh dari hasil review ahli materi, hasil review ahli media, hasil respon siswa, serta hasil tes kemampuan berpikir kritis siswa sebanyak 30 orang. Teknik pengumpulan data yang digunakan adalah a) validasi; b) angket; dan c) tes kemampuan berpikir kritis dengan instrumen yang digunakan adalah a) lembar validasi; b) lembar angket respon; dan c) lembar tes kemampuan berpikir kritis. Berdasarkan penelitian yang telah dilaksanakan, diperoleh data yang menunjukkan bahwa media Math Set Game valid, praktis dan efektif dalam meningkatkan kemampuan berpikir kritis siswa materi himpunan sehingga media Math Set Game layak digunakan dalam pembelajaran dan dapat disebarluaskan untuk kepentingan pendidikan.

Kata kunci: *Role Playing Game, Game, Himpunan Matematika*

Received : January 27, 2022

/Revised : February 20, 2022

/Accepted : April 21, 2022

/Published : May 1, 2022

Introduction

Mathematics is a science that plays an important role as a basis in the development of science and technology in the modern era. Mathematics has become a support force for the development of technology. Therefore, the quality of learning mathematics at every level of education needs to be pursued to the maximum along with the importance of mathematics in modern life. In fact, not a few students complain about math lessons because of the difficulty of the material, the boring learning process, and not exactly the use of the right methods and learning media. During this time the learning of mathematics is considered too formal, unrelated to the real world, and unattractive.

In math learning, there are several abilities that students must have, one of which is the ability to think critically. The ability to think critically is needed by everyone to deal with problems in the reality of life that will be faced. With the ability to think critically, a person can adjust, change, or improve his mind, so that he can take decisions to act more appropriately. People who think critically are individuals who think, act normatively, and are ready to reason about the quality of what they see, hear, or think (Maulana, 2013). Moreover, critical thinking is a process aimed at making sensible decisions about something to believe and do (Argikas & Khuzaini, 2016). The limits given in critical thinking are as complex processes involving the acceptance and mastery of data, data analysis, evaluation, and decision making selection or decision making based on the results of evaluation (Maulana, 2013). From some of the opinions expressed, it can be concluded that the ability to think critically is an individual attitude that occurs when someone sees, listens or listens. Think about something and the individual can decide to act normatively, quickly, and appropriately.

In the work of mathematics problems students can't be separated from the thought process, where students look for solutions to mathematical problems given from the knowledge they have (Mursari, 2020). Critical thinking in learning mathematics is a cognitive process of a person in an effort to acquire mathematical knowledge based on mathematical reasoning. There are six basic elements that need to be considered in critical thinking, namely focus, rationality, conclusion, situation, clarity and overall (Ginting et al., 2017). Practicing critical thinking skills in math learning can be done by giving out irregular problems related to daily life, with their presentation adjusted to the cognitive development of children. In addition to providing non-routine questions, student-centered learning will have the potential to train and develop critical thinking skills, as students have the opportunity to build their own knowledge, discuss, express opinions, accept or reject friend opinions, and tutor teachers in formulating (Yuni et al., 2017). This shows that students mathematical critical thinking skills can be trained or improved by learning that encourages students to be active in the learning process, and use the knowledge they have in solving non-routine problems to build new knowledge.

In achieving every goal and ability that will be obtained in learning mathematics, not only the relevant learning methods are needed, but also the use of learning media that are in accordance with today's life. Learning methods need to be transformed into more effective and practical learning methods. The use of appropriate learning media in schools needs to be optimized to streamline and facilitate the process of delivering learning content to students. Media is one of the factors that determine the success of learning. Media helps students and teachers communicate material in relation to the learning objectives set out in the lesson plan. In addition, creative use of media can increase student's interest in learning and student performance in achieving a learning goal. Learning media is a tool that can be manipulated and used to influence students minds and attitudes making it easier for the learning process. For that, it is necessary to improve the effectiveness of learning by using learning media. The presence of media in learning improves the communication process between teachers and students and helps students absorb and understand the material optimally. The new atmosphere of the development of mathematical learning media is learning with the utilization of multimedia. The use of multimedia that can be applied in the learning of mathematics of the modern era one of them is the utilization of educational games.

A game is something used to play that is played by certain rules (Saputri & Pratiwi, 2016). The game can also be defined as a situation in which a player engages with an artificial

problem and the player can interact in it (Batoq et al., 2015). In addition, a game is an activity that involves the player's decision to achieve the objectives of the game within certain rules (Meimaharani & Listyorini, 2015). Based on this opinion, it can be concluded that the game is something that has rules, objectives, and endings and the involvement of players during the process of achieving those goals and ends. Educational games are one of the categories of games that have elements of education and learning. Educational games are games developed to enhance interactive learning. Games are so close to student's daily lives that it is not an exaggeration if educational games used in math learning can create a new learning atmosphere. There are different types of games including RPG (role playing games) which is one of the favorite types of games at this time based on surveys conducted by Agate Studio & thesaa.com. The specialty of this RPG game is that the player must play by finishing the game according to the existing storyline. RPG Maker MV is suitable for game development in the learning process because it can be accessed on various platforms such as laptops, smartphones and even websites. The storyline given to RPG Maker MV can improve students critical thinking skills by thinking how to win games and get maximum scores.

Each level of education has its own level of difficulty, as well as the level of difficulty that exists in mathematics. The addition of education levels makes the material studied more diverse both from material variations and difficulties. Significant material change occurs at the change of level one of them from elementary school level to first school level. Students are expected to be ready to receive materials with new environments and new materials. Most math materials in junior high school have never been taught at the elementary school level. This is what triggers the number of students who have difficulty in understanding the material. This main part is the main topic for every teacher in developing learning methods or models and learning media to be used. One of the new materials at the junior high school level while in class VII is the set material. Therefore, is given special attention to students so that students are more interested and can enter the material.

Based on the background description above, researchers will take the research subjects of class VII students who are experiencing euphoria of changing levels of education with multimedia facilities in the form of educational games that will then be called "Math Set Game" because it contains mathematical set material in it. In this study, researchers will examine whether Math Set Game as an educational game can be a valid, practical and effective medium to improve the critical thinking process of grade VII students on set material. So, the title of the study taken is the Development of Math Set Game to Improve Critical Thinking Skills of Students of Class VII Material Set.

Research Methods

This study aims to describe the validity, practicality and effectiveness of Math Set Game as a learning medium to improve students critical thinking skills on set material. Based on these goals, this type of research is research and development. Development research is a systematic assessment of the design, development and evaluation of learning programs, processes and products that must meet the criteria of validation, practicality, and effectiveness (Seels et al., 1994). The development model used in this research is the ADDIE development model, which consists of Analysis, Design, Development, Implementation, Evaluation. ADDIE was first developed by Raiser & Mollenda in the 1990s. In the development of learning or instructional development, the main core is the ADDIE process (Branch et al.,

1999). Different types of product development such as media, models, and methods can apply the ADDIE model (Nuryanto et al., 2014). The steps to be taken in developing teaching materials and research instruments include 1) Preliminary Studies; 2) Product Development; and 3) Product Testing (Andriyani, 2017).

In this study, the data obtained is quantitative data. Quantitative data is obtained from the results of expert reviews of materials, results of expert media reviews, student response results, as well as test results of students' critical thinking skills as many as 30 people. The data collection techniques in this study were conducted with the aim of collecting the data needed to describe the validity, practicality and effectiveness of math set games. In this study, the data collection techniques used were: a) validation; b) questionnaire; and c) test critical thinking skills. The research instruments used in this study include: a) validation sheet; b) response questionnaire sheet; and c) critical thinking skills test sheet.

Validation data is obtained from validation by media expert lecturers and material experts in accordance with the aspects that have been determined. Data in the questionnaire provided five choices of answers in assessing product quality, namely, very good / very valid (5); good / valid (4); enough / valid enough (3); less good / less valid (2); and very less good / invalid (1). Then calculate the average score with the formula as follows: (Sugiyono, 2013)

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n} \quad (1)$$

Information:

\bar{x} = average instrument score

x_i = score on the item of the statement

n = many statements

Based on the formula 1, the average score is obtained from the number of scores in all statements divided by the number of statement items. Then the quantitative data is converted into interval data, as follows:

Table 1. Math Set Game Ratings Guidelines

Value	Value Interval	Category
5	$4,21 < \bar{x} \leq 5$	Highly Valid
4	$3,40 < \bar{x} \leq 4,21$	Valid
3	$2,60 < \bar{x} \leq 3,40$	Valid Enough
2	$1,79 < \bar{x} \leq 2,60$	Less Valid
1	$0 \leq \bar{x} \leq 1,79$	Invalid

In the table 1 it is explained that there are five categories of Math Set Game media equality suspension, where the media is said to be very valid when getting values that are in intervals $4,21 < \bar{x} \leq 5$, valid when in intervals $3,40 < \bar{x} \leq 4,21$, valid enough when in intervals $2,60 < \bar{x} \leq 3,40$, less valid when in intervals $1,79 < \bar{x} \leq 2,60$, and enter invalid categories

if they are in intervals $0 \leq \bar{x} \leq 1,79$. In this study, the Math Set Game learning medium from the whole aspect is said to be valid if it meets the value interval $3,40 < \bar{x} \leq 4,21$.

The practicality of the media can be known from the results of student responses, the rules of the response questionnaire first change qualitative data to quantitative with categories, among others: strongly agree (5); agree (4); half of disagree (3); disagree (2); and strongly disagree (1). Then calculate the response values of teachers and students with the following reference:

$$\begin{aligned} \text{NR SS} &= \sum R \times 5 \\ \text{NR S} &= \sum R \times 4 \\ \text{NR KS} &= \sum R \times 3 \\ \text{NR TS} &= \sum R \times 2 \\ \text{NR STS} &= \sum R \times 1 \end{aligned}$$

Information:

$$\begin{aligned} \text{NR SS} &= \text{response value for a strongly agreed answer} \\ \text{NR S} &= \text{response value for agreed answer} \\ \text{NR KS} &= \text{response value for half of disagreed answers} \\ \text{NR TS} &= \text{response value for disagreed answers} \\ \text{NR STS} &= \text{response value for strongly disagreed answer} \end{aligned}$$

Then look for the percentage of response values in each aspect with the formula:

$$\%NR = \frac{\sum_{i=1}^n \text{NR}}{\text{NR Maksimum}} \times 100\% \quad (2)$$

Information:

$$\begin{aligned} \%NR &= \text{Percentage of Response Values (NR)} \\ \sum_{i=1}^n \text{NR} &= \text{Total answer response value in each aspect} \\ \text{NR Maksimum} &= \text{Total overall value of response questionnaires in each aspect} \end{aligned}$$

The formula 2 for finding the percentage of student response scores is obtained from the total value of the answer response in each aspect divided by the total value of the overall response questionnaire in each aspect. After calculating the percentage of student response values, then determine the percentage criteria of response values in each aspect with reference:

Table 2. Percentage of Teacher and Student Response Scores

Category	Percentage
Very Strong	$80\% \leq NR \leq 100\%$
Strong	$60\% \leq NR < 80\%$
Enough	$40\% \leq NR < 60\%$
Weak	$20\% \leq NR < 40\%$
Very Weak	$0\% \leq NR < 20\%$

From the table 2 we know that the percentage of student response scores in determining the level of practicality is divided into 5 categories. These categories include, math set game media is said to be very strong when getting $80\% \leq NR \leq 100\%$ percentages, strong when getting percentages $60\% \leq NR < 80\%$, enough when getting percentages $40\% \leq NR < 60\%$, weak categories

when getting percentages $20\% \leq NR < 40\%$, and very weak when getting percentages $0\% \leq NR < 20\%$. In this study, if the overall aspect gets a percentage $\geq 60\%$ then the student response is positive so that the math set game learning media can be said to be practical, but if the percentage then the math set game learning media has not been accepted in learning $< 60\%$ and revision is needed.

The effectiveness of the media is tested through a test of critical thinking skills. Indicators of achievement are the improvement of students critical thinking skills from the Critical Thinking Skills Test 1 and the Critical Thinking Skills Test 2. Student test scores can be calculated by the formula 3:

$$x = \frac{\sum_{i=1}^k x_i}{\sum_{i=1}^k x_{i \text{ maks}}} \times 100 \quad (3)$$

Information:

$$\begin{aligned} x &= \text{student grades} \\ \sum_{i=1}^k x_i &= \text{number of test scores of study results obtained by students} \\ \sum_{i=1}^k x_{i \text{ maks}} &= \text{the total score of the study results test} \\ k &= \text{total of all test results} \end{aligned}$$

In the assessment of the test students obtained from the number of test scores of learning results divided by the number of overall test scores of learning results multiplied by 100. In this study, the learning medium Math Set Game from the overall aspect is said to be effective if student's grades can increase from TKBK 1 to TKBK 2.

Result and Discussions

In this study, the discussion is the results of testing the validity, effectiveness, and practicality of Math Set Game in improving the critical thinking skills of students of the set material.

Valid breast milk testing is conducted by media experts and material experts taken from Lecturers of Tidar University. Indicator validation by media experts consists of 17 indicators. Validation results data from breast milk by media experts are attached in the table below.

Table 3. Presentation of media expert validation data

No	Indicators	Value
1	The game can be <i>extracted</i> .	5
2	The game can be <i>run</i> .	5
3	Any options on the <i>title screen</i> can be run	5
4	Character movements displayed according to the selected command	4
5	The condition of the object displayed is in accordance with the conditions in real life, for example: the ground can be stepped on, the walls cannot be penetrated, cannot walk on water, and so on.	4
6	Material events can be run	4

No	Indicators	Value
7	Event issues can be run	4
8	Event opening can be run	4
9	Event ending can be run	4
10	Event saving can be run	4
11	Credit events can be run	3
12	Character transfer event from one place to another (<i>transfer between maps</i>) can be run	4
13	Outgoing sound effects (playable)	3
14	Image can be displayed	4
15	<i>Events</i> in each part of the <i>game</i> can run	5
16	The game can be exited.	5
17	Games can be removed	5

In table 3, several indicators are presented that determine the validity of the Math Set Game media, where in the 17 indicators contain all aspects used in the development of Math Set Game media, so that with these indicators, the media can be classified into which category of validity. Based on the table above, the average indicator value is 4.24. So based on validation by media experts, the Math Set Game media proved to be very valid because it meets the value interval $4,21 < \bar{x} \leq 5$. In addition to validation by media experts, Math Set Games are also validated by material experts. The material expert validation indicator consists of 20 indicators with validation data attached in the following table.

Table 4. Presentation of expert validation material

No	Indicators	Value
1	Clarity of learning objectives	4
2	Conformity of material to content standards	4
3	Scope of learning objectives	3
4	Depth of learning objectives	3
5	Accuracy of use of learning strategies	4
6	Media interactivity	5
7	Giving motivation to learn	4
8	Encourage students to get the right answers	4
9	The truth of the material presented	4
10	The novelty of the material presented	5
11	Completeness of material summary	3
12	Conformity of the material with the purpose of learning	3
13	Depth of material summary	3
14	Ease of summary of material to understand	4
15	Ease of understanding of the questions presented	4
16	Systematic summary of the material presented	3
17	Systematics of the presented	4
18	Use of language that is easy to understand	4
19	Clarity on what is presented	4
20	Accuracy of the problem with the purpose of learning	5

In table 4, indicators in determining expert validation of materials are based on the syllabus that applies at the time of learning. The category describes the feasibility of the material

contained in the Learning Media Math Set Game, so that Math Set Game can be categorized in which section is valid. Based on the table above, the average acquisition of validation values by material experts is 3.85. So based on validation by material experts, Math Set Game proved valid because it meets the value interval $3,40 < \bar{x} \leq 4,21$. Therefore, it can be inferred from the validation of media experts and material experts, obtained an average value of 4.05 so that Math Set Game is valid because it meets the value interval $3,40 < \bar{x} \leq 4,21$.

The practicality of math set game media can be from the results of student responses to the media. Student responses are obtained by collecting data through google form platform with 10 statement indicators. Data from student response to Math Set Game media is attached in the data below.

Table 5. Student Response Data

No	Indicators	Average Value
1	The learning medium "Math Set Game" is very interesting and fun	3,93
2	Through the learning medium "Math Set Game", I was able to master the set material better.	3,67
3	Presentation of material in the learning media "Math Set Game" is easy to understand	3,87
4	The learning medium "Math Set Game" made me have a high willingness to learn mathematics.	3,93
5	Problem training in the learning medium "Math Set Game" is very challenging to complete	3,93
6	The presentation of material in the learning media "Math Set Game" is very interesting	4,2
7	I feel satisfied when I am able to solve the problems in the learning media "Math Set Game"	3,93
8	I do not despair when wrong in doing problem training in the learning media "Math Set Game"	4
9	I understand all the material presented in the learning media "Math Set Game"	3,77
10	With the "Math Set Game" learning medium, I felt my critical thinking skills were being honed.	4,03

In table 5, there are indicators in determining students' responses to math set game media that have been applied in learning. These indicators start from the withdrawal of media, the content contained in the media, and the after effects of using the media. Data results of student responses to math set game media got an average score of 3.93 with a percentage of results of 78.6% in there of strong categories. So, it can be concluded that the overall aspect gets a percentage $\geq 60\%$ then the student response is positive so that the learning media Math Set Game can be said to be practical.

The effectiveness of the media is tested through a test of critical thinking skills. Critical thinking skills tests are carried out through math set game media during two games with different time frames. In the first test of critical thinking skills, the average student gained was 64.17. Next on the second critical thinking ability test, the average student increased to 80.53.

The difference between crime scenes 1 and 2 is 16.36 with an increase of 25.49%. So that the Math Set Game can be said to be effective because it can increase the test score of students critical thinking skills from stage 1 to 2.

The development of math set game teaching media is valid, practical, and effective in improving the critical thinking skills of students of set material. Similar media that has been developed before is a role playing game-based learning media with the name of the game "COC" which contains KPK material, this media is quite valid, practical, and effective (Eldiana & Muliawati, 2019). In addition, the development of other role playing game media, namely media with the game name "Paduka.exe." which contains composition function material, this media obtains a high enough level of validity, practicality and effectiveness so that the media developed can be utilized in learning activities (Nadifah, 2018). Other research develops Quantum Learning-based learning multimedia in rectangular and triangular languages, from the results of the study shows that multimedia learning plays an active role in encouraging more active and interesting learning so as to improve students' mathematical abilities (Zaharah et al., 2021).

Conclusion

The results of this research are obtained on average data validation results by media experts and material experts, with a value of 4.05 so that the Math Set Game is valid because it meets the interval of value data practicality $3,40 < \bar{x} \leq 4,21$. Of Math Set Game obtained from the results student response to Math Set Game, with a score obtained 3.93 with a percentage of results of 78.6% in the strong category, because the percentage of grades obtained $\geq 60\%$ then the student response is positive so that the learning Math Set Game can be said to be practical. Math Set Game media effectiveness tests are derived from critical thinking skills tests conducted in two stages. The results on the critical thinking ability test increased from an average initial score of 64.17 to an average final score of 80.53. The difference between crime scenes 1 and 2 is 16.36 with an increase of 25.49%, so math set game can be said to be effective because it can increase the test score of students critical thinking skills from stage 1 to 2. Based on the research that has been carried out, it can be concluded that the math set game is valid, practical and effective in improving the critical thinking skills of students of the set material, especially at the level of Junior class VII. Math Set Game is suitable for use in learning and can be disseminated for educational purposes. Furthermore, researchers also suggest to researchers who want to develop multimedia in order to develop multimedia mathematics learning using RPG Maker MV on other subjects to produce better and interesting mathematical learning multimedia.

Acknowledgement

I thank to Mr. Muhamad Ikhsan Sahal Guntur, M. Pd. as a lecturer in the course who helped direct the development of Math Set Game learning media. I am also grateful to all parties involved in the preparation of this article. Hopefully this article can be a useful article in the development of education in the future.

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