

Development of a Game-Based Test Instrument Using RPG Maker MZ Software on Exponential Functional Materials

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Abstract: This study aims to produce a game using software RPG Maker on valid, practical and reliable exponential function material. The type of research used is Research and Development with the ADDIE model. The product in this study was tested on class X students at SMK PGRI 2 Palembang in the even semester of the 2021/2022 academic year. With data collection techniques, namely interviews, validation questionnaires, student response questionnaires, and test questions. Product validity was seen from the validation questionnaire by three validators and obtained a score of 81.90% with a very valid category. The practicality of the product was seen from the student response questionnaire and obtained a score of 80.33% in the very practical category. Reliability is seen from the test results and obtained a reliability score of 0.608 with a high reliability category.

Keywords: Game Based Test, Software RPG Maker MZ, ADDIE model, exponential function

1. INTRODUCTION

The test instrument is a measuring tool used to collect and manage information and data to see the success of students in mastering learning outcomes [1]. In the era of the industrial revolution 4.0, tests are not only carried out via paper that is given directly, but such also as government products related to the Computer-Based National Assessment (ANBK) which will begin to be used in 2021 [2]. Tests using paper require a lot of equipment, educators also need time to correct students' answers and there are still many students who cheat so that educators do not understand real abilities and what material these students do not understand [3]. The development of technology-based test instruments is still very rare because educators' understanding of problem development using technology is still lacking. The positive impact of technology is the creation of various IT-based learning media that can assist in the learning process [4]. Making test instruments can also be developed in the form of games [2].

Games have the ability to encourage students' interest in learning, practice problem-solving skills, and learning using games can also increase perseverance, flexibility, curiosity, self-confidence, tenacity and patterns of thinking in math instruments [5]. The impact of games is that they forget to learn, so games that are made must consider various things so that games can educate, increase knowledge, improve skills and increase students' learning motivation [6]. Now there are many kinds of games played by students, several types of games themselves including Action, Adventure, Fighting, Racing, RPG, Shooter, Sport, Strategy, Board game/Card game, Music Game [7]. The survey results from Agate Studio show that out of 1200 gamers in Indonesia, 46% like RPG type games [8]. There are many kinds of software used to develop RPG-type games, one of which is RPG Maker [9].

In RPG Maker there are calculation parameters, game actor class settings, logic and algorithms for plotting per scene, animations and magic effects that support game creation [10]. The application used by researchers to make games is RPG Maker MZ, which is the game engine of the RPG Maker series, which was released on August 20 2020. RPG Maker MZ is an

application developed by Enterbrain and can be used to make Role Playing Games properly. RPG Maker MZ can be developed in the form of a smartphone application [11]. In December 2021, 59.22% of smartphone users in Indonesia used the Android operating system, 5.68% used the iOS operating system, and 29.09% used the Windows operating system [12]. The operating system can be described as a connecting device so that the products that have been created can be run by students [11].

This research is relevant to research conducted by [2], with the title design of a game-based mathematical problem-solving ability test instrument. However, research conducted by [2] uses the unity application, while in this study it uses the RPG Maker MZ application, both of which are game-making applications. In addition, the research conducted by [2] contains all mathematical material, whereas in this study only material for exponential functions is specific. The method used by [2] uses the R&D method with the ADDIE model, the same as this study. However, in [2] it only reached the design stage, whereas in this study it will be completed until the evaluation stage.

Based on the description of the problems above, this study aims to produce a product in the form of a game-based test instrument on exponential function material that can increase the attractiveness of students in working on practice questions, improve conceptual understanding and problem solving, increase the value of student learning outcomes and test instruments that suitable for use as a test tool that meets the criteria of valid, practical and reliable.

2. RESEACH METHODOLOGY

The method in this research is research and development. The research and development procedure used in this research is the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). This research was conducted at SMK PGRI 2 Palembang in the even semester of the 2021/2022 academic year. The data collection method used was interviews used to see product legibility, validation questionnaires were used to see product validity, student response questionnaires were used to see product practicality

and tests were used to determine validity, reliability, distinguishing power and item difficulty level.

1. Validity Analysis Techniques

Product validity was measured based on the results of a validation questionnaire which was validated by 3 validators. This questionnaire was made using a Likert scale from 1 to 5 for very good, good, moderate, poor, and very poor answers. analyzed by calculating the average answer based on the score of each answer from the expert with the following formula:

$$\text{Percentage} = \frac{\text{raw score}}{\text{maximum score}} \times 100\%$$

Furthermore, the percentage validity of the experts obtained is interpreted into validity criteria. The validity criteria by experts can be seen in the following table:

Table 1. Validity Criteria

Percentage Score (%)	Interpretation
0% - 20%	Very invalid
21% - 40%	Less valid
41% - 60%	Quite valid
61% - 80%	Valid
81% - 100%	Very valid

Source: [13]

The developed test instrument is said to be valid if the minimum percentage of validity reaches 61%.

2. Practicality Analysis Techniques

Based on the assessment response data from the implementation stage by students, it can be analyzed to see the practicality of the product. The student response sheet is a questionnaire that contains questions about the ease of use of the created game-based test instrument. To calculate the average score of student response questionnaires, the formula is used:

$$\text{Percentage} = \frac{\text{raw score}}{\text{maximum score}} \times 100\%$$

The results of these calculations are interpreted into practical criteria which can be seen in the following table:

Table 2. Practicality Criteria

Percentage Score (%)	Interpretation
80% - 100%	Very practical
60% - 80%	Practical
40% - 60%	Adequate
20% - 40%	Less practical
0% - 20%	Very impractical

Source: [14]

Based on the table above, a game-based test instrument can be said to be practical if it obtains a minimum percentage score of 60%.

3. Item Validity Test Techniques

The game-based test instrument on exponential function material that was tested at the field test stage was to see its empirical validity. The technique used to test the validity of the test questions is the product moment correlation technique proposed by Pearson (Arikunto, 2018).

$$r_{xy} = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{\{N \sum X^2 - (\sum X)^2\}\{N \sum Y^2 - (\sum Y)^2\}}}$$

Description:

r_{xy} = correlation coefficient between variable and variable, the two variables are correlated

N = Number of students

x = Scores of all students for each item

y = Scores of all students

The formula above is to find the validity of the questions as a whole test. The question is said to be valid if the calculated r value $> r$ table.

Table 3. Question Validity Criteria

Hasil r_{xy}	Interpretation
0.801 - 1.00	Very high
0.601 - 0.800	High
0.401 - 0.600	Sufficient
0.201 - 0.400	Low
0.00 - 0.200	Very Low

Source: [15]

4. Item Reliability Test Techniques

A test instrument will be reliable if the estimates are consistent or fixed. The purpose of holding a reliability test is to determine the consistency of the test equipment as a measuring tool so that the results can be trusted. The problem is said to be reliable if the calculated r value $> r$ table. For benchmarks the degree of reliability of the test used is as follows:

Table 4. Degree of Reliability

Interval	Interpretation
$0 < r_{11} \leq 0.200$	Very low reliability
$0.200 < r_{11} \leq 0.400$	Low reliability
$0.400 < r_{11} \leq 0.600$	Moderate reliability
$0.600 < r_{11} \leq 0.800$	High reliability
$0.800 < r_{11} \leq 1.00$	Very high reliability

Source: [15]

5. Difficulty Level Test Technique

The criterion used is the smaller the index obtained, the more difficult the test. Meanwhile, the greater the index obtained, the easier the test. The following table shows the difficulty index criteria:

Table 5. Difficulty Index Criteria

Difficulty Index	Difficulty Level Category
0 - 0.30	Difficult
0.31 - 0.70	Moderate
0.71 - 1.00	Easy

Source: [15]

Based on the criteria above, if students can work on the questions and get ≤ 0.30 it is categorized as difficult so the test questions are discarded. If you get an equals to 1 score, it is categorized as easy, so the test questions are still used or discarded according to their use.

6. Distinguishing Power Testing Technique

According to Arifin (2017), discriminating power is an estimate of the extent to which a test can identify students who have mastered the material and those who have not mastered the material. The formula used to calculate the discriminating power of the items is:

$$D = \frac{B_A}{J_A} - \frac{B_B}{J_B}$$

Description:

D = distinct power

B_A = The number of participants in the upper group who answered the questions correctly

B_B = The number of participants in the lower group who answered the questions correctly

J_A = The number of participants in the upper group

J_B = The number of participants in the lower group

Table 6. Distinct Power Criteria

Difficulty Index	Difficulty Level Category
0 - 0.20	Bad
0.21 - 0.40	Adequate
0.41 - 0.70	Good
0.71 - 1.00	Excellent

Source: [15]

3. RESULT AND DISCUSSION

3.1 Analysis

At the analysis stage, the researcher carried out a needs analysis and curriculum analysis. In the needs analysis, the researcher conducted a problem analysis by means of a literature study by reviewing journals about the need for game-based test instrument development. In the curriculum analysis the researcher determines the Basic Competency (KD) and Competency Achievement Indicators used.

3.2 Design

At the design stage, what the researchers did in designing the exponential function test instrument were: (a) Making a test grid of exponential function material according to KD and indicators at the curriculum analysis stage, and (b) Making question cards and answer keys on exponential function material. So that the resulting problem consists of 25 exponential function test questions.




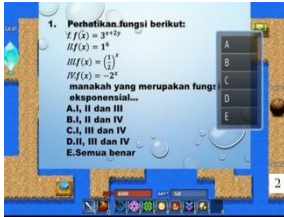

After the question creation process is complete, the next step is to create media or test kits using the RPG Maker MZ software. Before starting to design, the researcher made a game title that will be displayed at the beginning of the game, namely Exponential Function Problem Exploration. Activities in making media are (1) designing game intros, (2) designing game maps, (3) designing game characters, and (4) designing game events. The results of making the first game-based test instrument design are called prototype 1.

3.3 Development

The development stage consists of two stages, namely the validation stage and one to one trials. Validation was carried out on three validators to see validity and one to one trials were carried out on three students to see readability.

The prototype 1 validation stage still contains suggestions and comments from the validator which must be revised in order to produce a feasible product. The results of suggestions and comments from the validator on prototype 1 are presented in the following table.

Table 7. Validity Criteria

Before	After
Plants in the second location closer to the house. 	
The third location for placing the questions is too far away so it is not clear which way to look for questions. 	
The background questions in the game are all made uniform using a background, preferably using a colored background. 	
Instructions for playing the game are made 	

After going through the validation stage on prototype 1, it was revised to become prototype 2. Prototype 2 was then re-assessed by the validator and declared feasible to be tested at the next stage.

In the one-to-one trial phase, the researcher interviewed the three students to see the legibility of the game-based test instrument. Based on the results of the interviews, there were a number of questions that were too difficult and required a long time to calculate the answers, so the questions were corrected and reduced. Then the number of questions is 20 test questions. Changes to questions before and after revision based on validation results and one to one are prototype 3 which are presented in table 8 below:

Table 8. Changes to Prototype 1 and Prototype 2 Questions (Before and after Revision)

Before	Validator Comment	After
Question #1: Simple form of $\left(\frac{7x^3y^{-1}z^5}{49y^4z^2}\right)^2$ is ... a) $\frac{1}{7^2}x^6y^{-10}z^6$ b) $7^2x^6y^{-10}z^6$ c) $7^{-2}x^6y^{-10}z^6$ d) $7^4x^6y^{-10}z^6$ e) $\frac{1}{7^4}x^{-6}y^{10}z^6$	Questions number 1 and 3 are not in accordance with the question indicators.	Consider the following function, which is an exponential function: I. $f(x) = 3^{x+2y}$ II. $f(x) = 1^6$ III. $f(x) = \left(\frac{1}{2}\right)^x$ IV. $f(x) = -2^x$ a. I, II and III b. I, II and IV c. I, III and IV d. II, III and IV e. All true
Question #3: $4^{3036} - 4^{3021} = \dots$ $4^{3033} - 4^{3015} = \dots$ a) 4 b) 16 c) 36 d) 64 e) 256		Given $f(x) = 3^{2x-1}$, find the value of $f(2)$ is ... a. 9 b. 12 c. 16 d. 25 e. 27
Question #15: Value x that satisfies the equation $\frac{\sqrt[3]{(0,008)^{8-3x}}}{(0,2)^{-4x+5}} = 1$ is ... a. $-\frac{1}{2}$ b. $-\frac{1}{3}$ c. 0 d. $\frac{1}{2}$ e. $\frac{1}{3}$	The questions are too difficult on numbers 15, 19, and 20.	Question is not used.
Question #19: The limits of x satisfies $(0,6)^{x+\frac{5}{x}} < 0,046656$ is ... a. $\{x x < 1\}$ b. $\{x 1 > x > 5\}$ c. $\{x 1 < x > 5\}$ d. $\{x 1 > x < 5\}$ e. $\{x x > 5\}$		Question is not used.
Question #20: From an equality $\left(\sqrt[3]{\frac{1}{243}}\right)^{3x} \leq \left(\frac{9}{2^{2x-3}}\right)^2 \sqrt[3]{\frac{1}{27}}$, if x is a solution, then the value of $\frac{7}{2}x + 5$ is ... a. -1 b. 1 c. 3 d. 6 e. 9		Question is not used.

3.4 Implementation

The implementation stage consists of two stages, namely the small group stage and the field test. The small group stage was carried out for 15 students in class X TPM at SMK PGRI 2 Palembang which was held on May 17 2022. The Exponential Function Exponential Question Exploration application was given to students via telegram and students were asked to install the application. After playing the Exponential Function Question Exploration Application the researcher asked students to fill out a student response questionnaire. The results of the student response questionnaire answers were used to analyze the practicality of the game-based test instrument that had been developed.

The field test stage was carried out in 1 class consisting of 30 class X TI 3 students at SMK PGRI 2 Palembang. This field test trial was carried out in 2 meetings. In the first meeting, the researchers carried out teaching and learning activities to recall the exponential function material that had been studied. In the second meeting, the researchers gave a game-based test instrument or Exponential Function Exploration Application which was used as a test tool for students. This field test stage was carried out to see the validity of the items, the reliability of the questions, the level of difficulty and the discriminating power of the questions empirically.

3.5 Evaluation

In the evaluation stage, the researcher analyzed the results of the development and implementation stages whether the game-based test instrument using RPG Maker MZ software on exponential function material was valid, practical and reliable. The explanation of the analysis results from the evaluation stage is as follows:

a) Validation Questionnaire Analysis Results

The validity of a game-based test instrument that has been developed comes from validation questionnaire data from three validators. The results of the questionnaire assessment are as follows.

Table 9. Validator 3 Assessment Result

Validator	Percentage	Description
Validator 1	80.00%	Valid
Validator 2	81.14%	Very valid
Validator 3	84.57%	Very valid
Average	81.90%	Very valid

From table 9 above, it is known that the average rating of the three validators is 81.90%. Based on table 1, the validity criteria for this percentage are in the Very Valid category. Thus it can be concluded that prototype 2 is feasible to be tested to the next stage.

b) Results of Student Response Questionnaire Analysis

The practicality of a game-based test instrument that has been developed comes from student response questionnaire data. The results of the student response questionnaire are as follows:

Table 10. Student Response Questionnaire Recapitulation Results

No.	Question	Total Score	Maximum Score	%
1	The appearance of the math test using this application is interesting.	57	75	76.00

2	This math test makes me more enthusiastic in learning math.	58	75	77.33
3	Using this application makes learning mathematics not boring.	66	75	88.00
4	The visual appearance of this test is very interesting.	57	75	76.00
5	The test using this application increases my motivation.	62	75	82.67
6	I am very interested in game-based tests using this application.	56	75	74.67
7	Learning mathematics with game-based tests using this application is less useful for me.	57	75	76.00
8	I prefer to work on test questions using this application.	58	75	77.33
9	The questions given are in accordance with what I learned at school.	62	75	82.67
10	The math test using this application is very practical.	60	75	80.00
11	The material presented is easy to understand.	63	75	84.00
12	This test tests the extent of my understanding of the material that has been studied at school.	63	75	84.00
13	The sentences used in the questions are clear and easy to understand.	64	75	85.33
14	The language used in this test is simple and easy to understand.	63	75	84.00
15	The mathematical symbols used are simple and easy to read.	63	75	84.00
16	With this application it is very easy at the time of the test.	59	75	78.67
17	It is more difficult to understand the questions given in this application.	60	75	80.00
18	This application is easy to access.	59	75	78.67

19	This application is easy to use.	62	75	82.67
20	The menus and buttons on this application are easy to use.	56	75	74.67
Average				80.33

From table 10 above, it can be seen that the average percentage of students' answers is 80.33%. Based on table 2 the practicality criteria, the percentage is in the practical category. So it can be concluded that the game-based test instrument is stated to be practical for use in the learning process.

c) Results of Analysis of the Validity of the Question Items

After the field test phase is completed and the results obtained from the test are obtained, the researcher then analyzes the answers of students. The item validity calculation is done by determining the product moment correlation from Karl Pearson using the SPSS 28 application. The calculation results show that 14 questions are valid, and 6 questions are invalid in question numbers 8, 9, 10, 12, 13, and 18 as shown in table 11 below.

Table 11. Validity Result

Question	r_{xy}	r_{table}	Description
1	0.415	0.361	Valid
2	0.415	0.361	Valid
3	0.415	0.361	Valid
4	0.578	0.361	Valid
5	0.402	0.361	Valid
6	0.415	0.361	Valid
7	0.415	0.361	Valid
8	0.151	0.361	Not valid
9	0.151	0.361	Not valid
10	0.234	0.361	Not valid
11	0.591	0.361	Valid
12	0.097	0.361	Not valid
13	0.054	0.361	Not valid
14	0.415	0.361	Valid
15	0.378	0.361	Valid
16	0.390	0.361	Valid
17	0.415	0.361	Valid
18	-0.036	0.361	Not valid
19	0.618	0.361	Valid
20	0.415	0.361	Valid

d) Results of Item Reliability Analysis

To see the level of reliability of game-based test instruments that have been developed, researchers used the Alpha Cronbach formula using the SPSS 28 application. The results of the reliability test questions are seen in table 12 below:

Table 12. Reliability Result

Cronbach's Alpha	N of items
0.608	20

Based on table 12 above it is known that the reliability coefficient obtained is 0.608 with high reliability criteria based on table 3.8. So it can be concluded that the 20 questions analyzed were reliable.

e) The results of the analysis of the difficulty level of the questions

Then to see the level of difficulty of the game-based test questions that have been developed, the researcher uses the SPSS 28 application and the calculation results are as follows:

Table 13. Difficulty Level Result

Question Number	Difficulty Level	Criteria
1	0.97	Easy
2	0.97	Easy
3	0.97	Easy
4	0.73	Easy
5	0.93	Easy
6	0.97	Easy
7	0.97	Easy
8	0.90	Easy
9	0.90	Easy
10	0.97	Easy
11	0.63	Moderate
12	0.90	Easy
13	0.97	Easy
14	0.97	Easy
15	0.67	Moderate
16	0.63	Moderate
17	0.97	Easy
18	0.97	Easy
19	0.67	Moderate
20	0.97	Easy

Based on table 13 above the results obtained from the 20 questions that have been tested there are 16 questions in the easy category, and 4 questions in the medium category.

f) Results of the Analysis of the Discriminating Power of the Problem

To see the level of discriminating power of game-based test items that have been developed, the researcher used the SPSS 28 application with the following results:

Based on table 14 below, the data obtained from the calculation of discriminating power is that there are 8 in the Bad category, 9 in the Fair category and 3 in the good category.

Table 14. Difficulty Level Result

Question Number	Distinct Power Level	Criteria
1	0.339	Adequate
2	0.339	Adequate
3	0.339	Adequate
4	0.407	Good
5	0.294	Adequate
6	0.339	Adequate
7	0.339	Adequate
8	0.005	Bad
9	0.005	Bad
10	0.150	Bad
11	0.405	Good
12	-0.049	Bad
13	-0.033	Bad
14	0.339	Adequate
15	0.159	Bad
16	0.167	Bad
17	0.339	Adequate
18	-0.122	Bad
19	0.444	Good
20	0.339	Adequate

Based on table 14 above, the data obtained from the calculation of discriminating power is that there are 8 in the Bad category, 9 in the Fair category and 3 in the Good category.

4. CONCLUSION

Based on the results of research and discussion on the development of game-based test instruments using RPG Maker MZ software on exponential function material, it is known that the validity of game-based test instruments obtained an average percentage of 3 validators of 81.90% with a very valid category. The practicality of game-based test instruments was obtained from students' assessment of game-based test instruments by filling out a student response questionnaire. The results of the assessment obtained a percentage of 80.33% in the practical category. Empirical validity, reliability, difficulty level and differentiability of game-based tests were obtained from the results of field tests. The results of the calculation of the validity of the items show that 14 questions are valid, 20 questions are reliable at 0.608 with a high reliability category, in the calculation of the level of difficulty there are 16 questions in the easy category, and 4 questions in the medium category, and the results of the calculation of discriminating power are 8 in the Bad category, 9 in the Enough category and 3 in the Good category.

5. RECOMMENDATION

Research suggests that the development of test instruments can be in the form of short questions or matching in order to reduce the possibility of guessing answers.

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