

OPTIMIZATION OF NUMERACY LEARNING IN ELEMENTARY SCHOOLS THROUGH INNOVATION IN THE DEVELOPMENT OF CONSTRUCT 2-BASED GAME "FISH MATH"

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Abstract

This study aims to describe the development process of an interesting educational game "Fish Math" using the Construct 2 platform as a solution to overcome difficulties in mathematics learning, especially calculations, faced by students, by ensuring the validity, practicality, and effectiveness of the development. The development method follows the 4D model by Thiagarajan with a focus on the "design" and "develop" stages. Data was collected through interviews, questionnaires, and tests, and validated by material experts, media experts, and education practitioners. The trial involved 10 grade VI students at Jatilawang 02 State Elementary School, Kramat District, Tegal Regency. The validation results of this educational game "Fish Math" show the percentage of validity from the average total validation of 90% with very valid criteria. Analysis of pretest and posttest tests calculated using the t test with $\alpha = 0.05$ then criterion using n-gain resulted in a percentage of 76.65% with effective criteria. This final product is an educational game "Fish Math" based on Construct 2 that is interesting and fulfills validity, practicality, and effectiveness in optimizing student numeracy learning.

Keywords: Construct 2, Game Education, Numeracy learning, Development

1 INTRODUCTION

Learning mathematics at the primary school level is still faced with complex challenges, which many students consider as a difficult subject. Mathematics is an important foundation in education and plays a crucial role in achieving overall learning success [1]. One of the factors that can affect student learning outcomes is interest in learning. To increase interest in learning, information and communication technology (ICT)-based learning approaches can be an effective solution in the context of education [2]. Then there are many things that must be mastered by students, one of which is in mathematics subjects in class VI must have the ability to count. In principle, mathematics learning involves the process of honing the ability to think logically, structured, continuously, and able to present convincing evidence in every statement expressed [3].

The use of media used in the mathematics learning process will have an influence on students in understanding the subject matter delivered by the teacher [4]. Because learning using media can be designed to be a fun, interesting learning so that students do not get bored quickly, and can motivate and stimulate students to be enthusiastic in learning, because this can support the achievement of effective and efficient learning goals [5]. Learning media is currently made as attractive as possible to facilitate the teaching and learning process, becoming a more interesting teaching and learning activity, namely by combining elements of education and elements of entertainment [6]. One of them is the use of educational games that have a very relevant role in the educational context and become an innovation if there is an integration between technology and learning through mobile devices or smartphones [7].

The learning media developed is packaged in the form of an educational game based on Construct 2. Games have become a means of entertainment that is most in demand by the public, especially among young children today. This is the factor that encourages many game developers to innovate with game products that have a positive impact on their enthusiasts [8]. Sometimes playing games is seen as an unproductive activity [9]. However, by including learning elements in it, the game can be used as an instructional system.

Then from the results of initial observations using the method of disseminating tests and interviews conducted at Jatilawang 02 Elementary School with class VI teacher resource persons, information was obtained that the teacher had not used other media that could attract students' interest in learning mathematics, especially in the material of integer calculation operations. And students love to play games. It takes fun learning media as well as helping in learning mathematics.

So researchers will develop one form of learning media in the form of an educational game based on Construct 2 that is relevant to the current situation entitled "Optimization of Numeracy Learning in Elementary Schools through Innovation in the Development of Construct 2-Based game Fish Math".

Based on the background above, the purpose of this study is to determine the development process of an interesting Fish Math game based on Construct 2 in optimizing valid, practical, and effective numeracy learning for elementary school students.

2 METHODOLOGY

This research is a type of research and development or Research and Development (R&D). This type of R&D research is a research method used to produce certain products and test the effectiveness of those products [10]. This development research aims to create learning media on integer calculation operation material using valid, practical, and effective educational games. By developing this product, it is expected to provide solutions for teachers in learning activities, especially in an effort to overcome student numeracy problems, so that during learning activities students will feel happy, motivated, and not bored.

This research uses Thiagarajan's model development design. The Thiagarajan model is known as the 4D model. The 4D Model (Four D Models) has 4 stages of development, namely: Define; Design; Develop; Disseminate [11]. However, this research focuses on the design stage and the develop stage only.

Data collection techniques in this study are interviews, documentation, and tests. The technical data analysis used in this research and development is a quantitative data analysis technique obtained from media validation questionnaires by material experts, media experts, education practitioners, student response results, and student learning test results. Qualitative data analysis techniques are obtained from comments and suggestions from validators. Suggestions and comments will be used to revise mathematics learning media products with Construct 2-based game media on integer calculation operation material. The assessment technique analyzes the validity and practicality of the media using a Likert scale with a rating scale of 1-4.

The results of the validation percentage from material experts, media experts, and education practitioners can be grouped into the following criteria:

Table 1. Percentage-based validity criteria

Achievement Level	Criterion	Information
81% – 100%	Highly Valid	No Revision
61% – 80%	Valid	No Revision
41% – 60%	Quite Valid	Partial Revision
21% – 40%	Less Valid	Revision
0% – 20%	Very Less Valid	Revision

Then the results of the percentage of student response questionnaires can be criterion as follows:

Table 2. Practicality criteria based on percentages

Percentage	Criterion
81% – 100%	Very Practical
61% – 80%	Practical
41% – 60%	Quite Practical
21% – 40%	Impractical
0% – 20%	Very Impractical

Data analysis of the effectiveness of using the Fish Math game in this study was by calculating pretest and posttest values using the t-test formula [10]. The average increase in learning outcomes by students can be calculated using the formula [12]:

$$N - Gain = \frac{\text{posttest value} - \text{pretest value}}{\text{maximum value} - \text{pretest value}}$$

Furthermore, the calculation results are classified according to the criteria applied. The criteria are as follows [13]:

Table 3. *N-gain test value effectiveness criteria*

Percentage	Criterion
0% - 40%	Ineffective
40% - 55%	Less Effective
56% - 75%	Quite Effective
76% - 100%	Effective


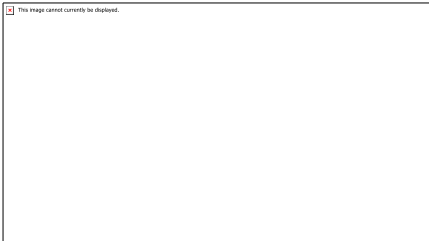
3 RESULTS

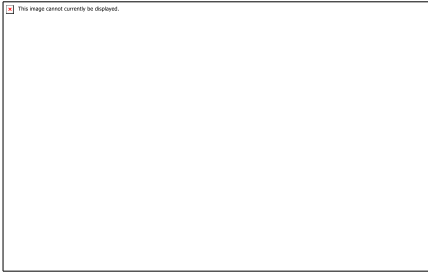
This research was conducted to develop learning media Fish Math Game based on Construct 2. The manufacturing process is carried out according to the stages of the 4D development model. The results obtained are in accordance with the 4D stages that focus on the "design" and "develop" stages.

3.1 Design

At this stage, the process of designing learning media in the form of games on integer calculation operation material, so as to produce games based on prototype procedures, namely invalid media displays. The media developed is called Fish Math game based on Construct 2. Activities that include the design stage include program identification, namely the material presented in the Fish Math game learning media is integer calculation operation problems, collecting supporting materials such as audio files, images / characters, and logos, determining the game genre, namely the interactive genre, determining software using Construct 2 software, and storyboards.

Table 4. *Fish Math Game media display*

Display	Information
	<p>Home Screen</p> <p>This screen displays the game logo and loading.</p>
	<p>Start Screen</p> <p>After the Start Screen will appear Start Screen. This Start screen displays the logo and game start button. If the start button is pressed, it will go to the Main Menu.</p>



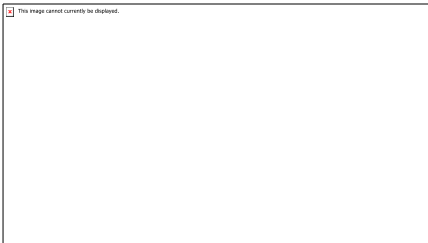
Main Menu

On this screen will display a sound settings button that functions to turn off or turn on the sound. In addition, there are Basic Competencies, Learning Objectives, and Play menus. If pressed, the information will appear.



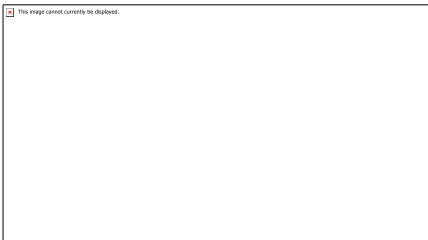
Basic Competency Submenu

The Basic Competency submenu contains the contents of the Basic Competency in accordance with the integer calculation operation material.



Learning Objectives submenu

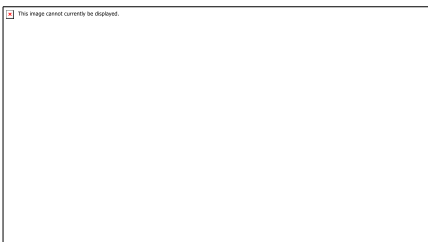
The Learning Objectives submenu contains the contents of the Learning Objectives that correspond to the integer calculation operation material.



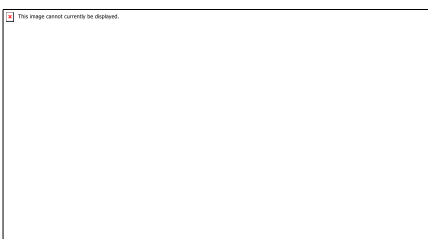
Play Submenu (Level Select)

The play submenu contains a game containing 5 levels. In the play submenu there are level 1 to level 5 buttons and a BACK button. Players only need to press or click once on the level button on the Play submenu to be able to complete the game. Here, players can freely choose the level they will play.

Level 1-5 Play Screen

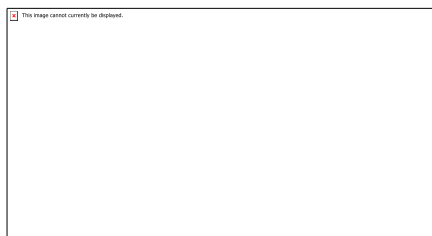


On each button the level of the game contains a game with a fish character. Each level has a different time according to the type of question each level. At level 1 with 20 seconds per question, level 2 with 30 seconds per question, level 3 with 40 seconds per question, level 4 with 50 seconds per question, level 5 with 60 seconds per question. Here, to go to the next question the time will be repeated according to the time of each level. Then in this game each correct answer score increases by 10 points and the fish will move forward towards the finish line.



Game Over Screen

For the Game Over screen will appear if the player answers the wrong question or the specified time has run out will display the last score of each level. In addition, there is a Repeat button, when pressed it will return to the play menu screen.



Complete Level Screen

The Complete Level screen will appear when the player has answered all questions with a maximum score of 100. In addition, there is a reset button, when pressed it will return to the play menu screen.

3.2 Develop

3.2.1 Analysis of Product Validity and Revision Data

After the Fish Math game design was completed, then researchers tested the validity of experts. These experts are material experts, media experts, and educational practitioners, the goal is to find out the validity of the media. The following are presented the results of the validation of Fish Math game learning media based on Construct 2 that have been given by validators.

Table 5. Media validation results

Validation	R	SM	%	Criterion	Information
Material Expert	108	120	90	Highly Valid	No Revision
Media Expert	111	120	92,5	Highly Valid	No Revision
Education Practitioner	105	120	87,5	Highly Valid	No Revision
SUM	324	360	90	Highly Valid	No Revision

Based on table 5 that the Fish Math game learning media that has been developed has a level of validity with very valid criteria. This is evidenced by the average results of the scores given by validators to the Fish Math game learning media with a validity percentage reaching 90%.

3.2.2 Practical Data Analysis

To see the practicality of this Fish Math game, a limited trial was conducted totaling 10 students in grade VI of Jatilawang 02 Elementary School. Data on the practicalization of the Fish Math game that has been designed was obtained from student response questionnaires. Researchers collected data from students regarding media display, material presentation, and media benefits. Broadly speaking, the results of student responses to product practicality can be seen in the following table:

Table 6. Student response questionnaire results

Indikator	Σx	Σx_i	%	Criterion
Fish Math game has an attractive look	36	40	90	Very Practical
Fish Math game character animations are interesting	38	40	95	Very Practical
Fish Math game is interesting as a learning medium	33	40	82,5	Very Practical
Fish Math game is easy to operate	35	40	87,5	Very Practical
The integer calculation operation problems in the Fish Math game are easy to understand	35	40	87,5	Very Practical
Fish Math games can foster learning motivation	38	40	95	Very Practical
Fish Math games make practice questions fun	39	40	97,5	Very Practical

I was helped in practicing questions while using this game	39	40	97,5	Very Practical
I am interested in learning integer count operations using this game	39	40	97,5	Very Practical
I was encouraged to practice integer calculation operations using this game	38	40	96	Very Practical
SUM	370	400	92,5	Very Practical

Based on table 6, the overall test of the Fish Math game is very practical with an average of 92.5%. This means that in general students give a good appreciation in the use of this Fish Math game. Because it makes it easier for students to overcome counting problems, gives enthusiasm for learning, and is interesting for students to learn.

3.2.3 Data Analysis of Fish Math Game Effectiveness

In the trial of using Fish Math game learning media, researchers conducted tests in the form of pretest and posttest to find out whether grade VI students of Jatilawang 02 Elementary School after using the Fish Math game that had been developed by researchers there were differences in learning outcomes before and after using the Fish Math game. Pretest was done before using the Fish Math game, while posttest was done after students used the Fish Math game.

Table 7. Game effectiveness calculation results

No.	Name	Value		N-Gain(%)	Criterion
		Pretest (x_1)	Posttest (x_2)		
1	AR	32	88	82,35	Effective
2	AS	40	92	86,67	Effective
3	AF	40	80	66,67	Quite Effective
4	AZA	40	88	80	Effective
5	FSA	48	92	84,62	Effective
6	MMA	60	80	50	Less Effectiveness
7	MMY	48	88	76,92	Effective
8	NAW	56	96	90,91	Effective
9	RDS	52	80	58,33	Quite Effective
10	SKP	60	100	100	Effective
Average		47,6	88,4	76,65	Effective

Based on table 7, the calculation of the percentage of normal student gain calculation results is 76.65%, so the Development of Construct 2-Based Fish Math Game is effective in optimizing numeracy learning for grade VI students of Jatilawang 02 Elementary School, Kramat District, Tegal Regency.

4 CONCLUSIONS

Based on the results and discussion of the development research that the researchers conducted, the conclusions obtained are as follows:

1. The Fish Math game developed meets the criteria of being very valid by validators with an average score of 90% total validation of Fish Math games. With details of the assessment of material

- experts of 90% with very valid criteria, media experts of 92.5% with very valid criteria, and education practitioners of 87.5% with very valid criteria.
2. The Fish Math game developed meets very practical criteria obtained from the results of the response questionnaire of grade VI students of Jatilawang 02 Elementary School with a percentage result of 92.5%.
 3. The Fish Math game developed meets the criteria of being effectively used as a practice media in an effort to overcome the numeracy problems of grade VI students of Jatilawang 02 Elementary School, Kramat District, Tegal Regency. This can be seen from the percentage result of 76.65%.

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