

Validity Analysis of Digital Puzzle Game Media with a Realistic Mathematics Education Approach on Arithmetic Operations Material for Early Childhood

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Abstract. Early childhood in the era of digital development is in a unique process of growth and development. Children have growth and development patterns, thinking power, creativity, language and communication, which are included in intellectual intelligence, emotional intelligence, spiritual intelligence, according to the child's growth and development level. The purpose of the results of this study is to produce a product in the form of a digital puzzle game media with arithmetic operations material approach Realistic Mathematics Education for Kindergartens. The method in this article uses 4 stages, namely 1) potential and problems, 2) data collection, 3) product design, 4) design validation. The output that has been achieved in this study is that a valid digital puzzle game based of RME product is produced on validity tests from material experts and media experts. Based on the results of the average assessment obtained from material experts that is equal 89,43% and the average assessment of media experts is equal 91,64%, It can be concluded that the results of the digital puzzle game media assessment of material experts and media experts are classified as very worth it and the digital puzzle game based of RME media is suitable for use by kindergarten students at Kekancan Mukti and IT Harapan Bunda.

1 Introduction

The education that is really needed at this time is education that can integrate character education with education that can optimize the development of all dimensions of children (cognitive, physical, social-emotional, creative and spiritual). Education with this educational model is oriented towards the formation of children as complete human beings [1].

In the learning context in the Early Childhood Education (PAUD) environment, all activities require tools as learning media. The most effective tools for early childhood are educational games (APE). Playing is a very important way of learning for young children. [2] Through play, the activities that are expected to take place in PAUD are fun, interesting

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and meaningful for young children. For children, playing is their duty and also a means of learning.

Play activities help children to explore every object they encounter in the natural environment through observing objects, both living and inanimate objects. The closest way to a child's developmental phase to understand their world is through playing. Through play, children's cognitive development as one of the determinants in developing children's skills can be stimulated, so that children have the ability to solve every problem, think logically and symbolically, and can manage their minds. In Piaget's theory, play not only reflects the attitude of cognitive development, but also the child himself while contributing to the child's cognitive development [4]. The formation of knowledge, attitudes and skills as an implication of early childhood cognitive development cannot be separated from the role of teachers as educators. If the learning process through play is carried out by the teacher using game tools that are varied, fun and interesting, it will have strong potential for children's cognitive development, conversely if the teacher is not creative and innovative then the target for achieving children's cognitive development will not develop according to expectations.

Furthermore, according to the aim of puzzle games, namely that they can train accuracy, can develop children's cognitive, patience and concentration. Thus, the puzzle game is considered suitable for use by children aged 0-6 years, with different levels of difficulty. Apart from its unique shape, it also contains aesthetic value which makes children feel interested. According to Supartini, one of the benefits of playing puzzles is that it trains and helps [5] cognitive skills. If interpreted briefly, a puzzle game is a game of disassembly.

In the current digital era, puzzle games that can develop aspects of cognitive development can be done digitally using cellphones, laptops, tablets and other electronic devices. One of them is a puzzle game that can be played on a cellphone or laptop via the Children's puzzle game application which has been downloaded on an Android/cellphone.

As a result of observations that researchers have made, it is known that students do not understand the use of mathematics or what mathematics will be used for, especially in their daily lives. Apart from that, there are several things that influence education in schools, one of which is the learning method/approach/model [6]. It can be seen that teachers who still carry out learning use conventional learning, namely direct learning. This causes students to appear passive and not understand mathematics. This condition is then thought to be the cause of low student learning outcomes. Based on these apparent problems, the solution offered is using game-based media.

One of the approaches to learning that can be used by mathematics teachers is the Realistic Mathematic Education (RME) approach [7]. RME or Realistic Mathematics Education is an approach that was first introduced and developed in the Netherlands in 1970 by the Freudenthal Institute [8]. This theory says that mathematics must be linked to reality and mathematics is a human activity. This means that mathematics taught by teachers should be related to the realities of life experienced by their students so that the knowledge taught is embedded in students and can be used to solve problems related to their daily lives or solve problems related to that knowledge in the field. Others [9] argue that the RME approach has the potential to improve students' mathematical understanding. If students' understanding of mathematics improves, their learning outcomes will also automatically increase, especially in the cognitive aspect.

The results of research by [10] show that the realistic mathematics learning approach is effective for student learning outcomes. Therefore, the Realistic Mathematic Education (RME) approach is an appropriate learning alternative that can combine real problems known to students and involve students' active role in learning so that it can improve students' mathematics learning outcomes.

Based on the problems explained above, the researcher formulated a problem, namely analysis of digital puzzle game media with a realistic mathematics education approach on arithmetic operations material for early childhood.

2 Methodology

Participants in this research were students at Kekancan Mukti Kindergarten and Harapan Bunda IT Kindergarten in Semarang. The population for this study included all Class B students, while the sample comprised students from conventional and media classes, with each sample consisting of 23 students.

The research design and procedure outlined in this article utilized a research and development approach. This study is classified as a type of learning media development [11]. The steps of the development research in this study are presented in the following chart:

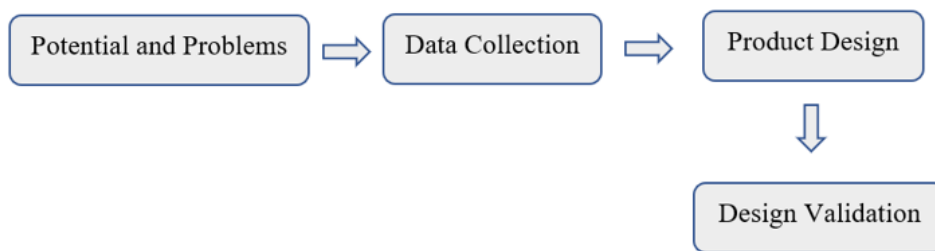


Fig 1. Schematic of Research and Development Design

From the diagram above, the research steps consist of six stages there are potential and problems, data collection, product design, design validation.

This test was conducted with students from Kekancan Mukti Kindergarten and Harapan Bunda IT Kindergarten in Semarang, focusing on a limited set of arithmetic operations. A total of 23 children were selected for the initial trial of this learning media. This research was conducted over a period of eight months, from February to September 2024.

The data analysis technique used in this research is quantitative data analysis technique. The assessment data obtained from the validator is analyzed descriptively qualitatively and used as a reference for revising the product, thereby producing a viable product. The product design developed is assessed by validators using a validation sheet. The results of the assessment of all aspects are measured using a Likert Scale. The Likert scale is a number of positive or negative statements about an attitude object. The basic principle of the Likert scale is to determine the location of a person's position on a continuum of attitudes towards an attitude object ranging from very negative to very positive [12].

In this study, the answers to the instrument items were classified into five choices. Each indicator measured is given a score on a scale of 1-5, namely:

Table 1. instrument indicator measured

Indicator Score	Qualification Category
5	very good/very suitable/very appropriate/very clear

4	good/suitable/decent/clear
3	not good/not suitable/not suitable/not enough clear
2	not good/not appropriate/not appropriate/unclear
1	very not good/very inappropriate/very inappropriate/very unclear

The next step is to assess the feasibility of a learning media to be implemented in the arithmetic operations material at Kekancan Mukti Kindergarten and Harapan Bunda IT Kindergarten in Semarang. After the data is obtained, then look at the weight of each response and calculate the average score using the following formula.

$$\bar{x} = \frac{\sum x}{n} \tag{1}$$

Information:

\bar{x} : Average score

n : Total evaluation

$\sum x$: Total score of each

Then the formula for the percentage of results can be calculated using the following formula.

$$\text{Result} = \frac{\text{Total score obtained}}{\text{maximum score}} \times 100\% \tag{2}$$

Eligibility categories are based on the following criteria [13].

Table 2. Media eligibility criteria

No	Score in percent (%)	Qualification Category
1	< 21 %	Not really worth it
2	21 – 40 %	Not feasible
3	41 – 60 %	Decent Enough
4	61 – 80 %	Worth it
5	81 – 100 %	Very Worth It

3 Results and Discussions

The results achieved in this research are a digital puzzle game based on arithmetic operations material which has been validated by material experts and media experts. This product is the result of media innovation for early childhood because previously schools only used conventional puzzle media. The following are the results of digital puzzle game media products using the RME approach:



Fig 2. Digital puzzle game cover product with arithmetic operations material

Cover game puzzle digital menu display consists of play, on and off music and animation character. First the play button functions to see what material is on the media application. The two on and off music buttons function to play and turn off the instrumental music that is on the media application. The merging of the game puzzle digital display design using Corel Draw software is then processed by adding a script using adobe animate CC.



Fig 3. Material puzzles about getting arithmetic operations

In the material arithmetic operations, there are 5 puzzles to choose from. Each puzzle contains different material and questions. So that children don't get bored playing games. In the digital puzzle game arithmetic operations at the bottom right there is an exit button.



Fig 4. Digital puzzle game display arithmetic operations

In the game display there are 9 boxes containing puzzle pieces, each puzzle has numbers 1 to 9 and there are different colors. Children can practice and learn to name the numbers and colors in each box. At the bottom right there is also a menu button to select another puzzle again.



Fig 5. Display of digital puzzle game on arithmetic operations material

Display examples of puzzle results arithmetic operations. In the puzzle display there are 3 exercises that children can do. This question contains children's introduction to transportation and counting exercises.

The discussions results media application digital game puzzle has been validated using an questionnaire. The questionnaire obtained responses from material experts and media experts. The following assessment percentages are presented in the form stem diagram below:

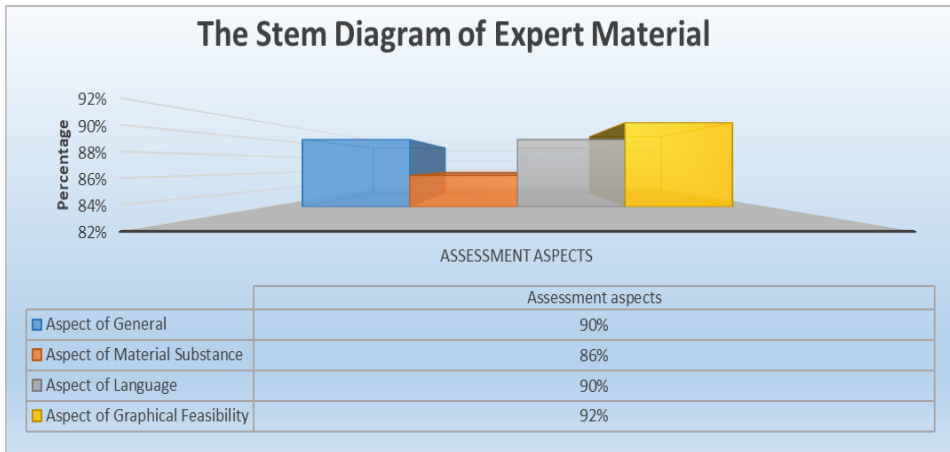


Fig 6. The stem diagram of expert material

Based on the percentage picture above, the material expert evaluates the application product that is 90% general aspect, which means that arithmetic operations materials is easy enough to be understood by students, 86% learning presentation aspect means that this teaching material is quite complete, there are examples of questions, practice questions and summaries, aspects of language 90%, which means the use of language in this teaching material is in accordance with the level of intellectual development of students, the feasibility aspect of the graph is 92%, which means the sentences and images in the arithmetic operations material are quite clear.

Based on the results of interviews with material experts, it is suggested that the material in digital puzzle games contains the practice questions in the digital puzzle game contain questions that are straightforward and easy for users to understand. The digital puzzle game already has a variety of practice questions on arithmetic operations about transportation that are quite good. In the arithmetic operation material, it is necessary to add a story about introducing transportation according to its type so that it will be more interesting. There needs to be additional animation about more transportation so that it will look more interactive. Furthermore, the following is results of the media expert questionnaire. The grading percentages are presented in the form stem diagram below:

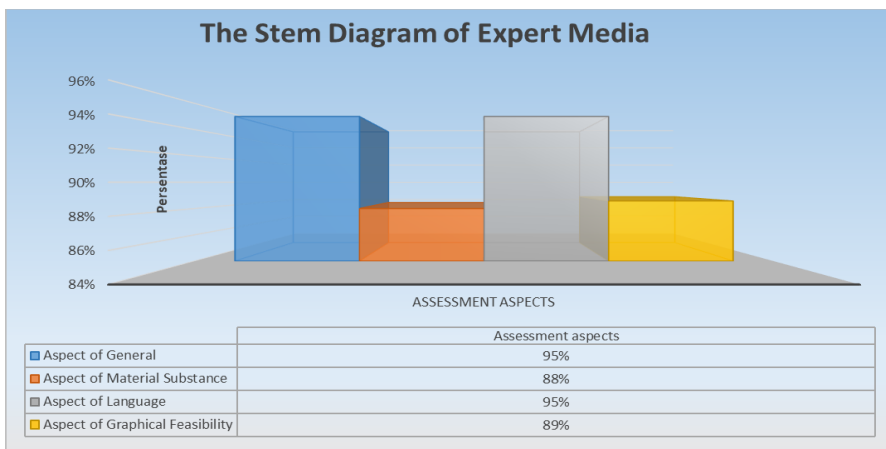


Fig 7. The stem diagram of expert media

Based on the diagram of the results of the adoption of media experts, the assessment of game puzzle digital media products is a general aspect of 95%, which means that the media of the application is classified as creative and innovative media, 88% of the learning presentation aspect means that the systematics and media presentation of the game puzzle digital media are good, the aspect of language feasibility is 95%, it means the level the use of language and language norms is reasonable, the feasibility aspect of 89% means that the appearance of the layout and color elements match the background requirements.

Based on the results of interviews with media experts, it was suggested that the use of color and animation in digital puzzle game media is sufficient and good. In the media there is instrumental music so that it will add variety to children's learning. The game is in apk format, so it can be applied to android mobile phone users. There should be rules for using the game so that users know the steps for using the game. There should be next and back buttons on each page so that users can go directly to the next page.

From the description of the assessment and interview above, the average result of an digital puzzle game media assessment obtained by material experts is 89,43%. While the average digital puzzle game media assessment by media experts is 91,64%. It can be concluded that the results of the digital puzzle game media assessment of material experts and media experts are classified as very worth it. Where as based on the results of the interview there needs to be revisions related to relating to the appearance and material but for the whole it is appropriate to be used on students. It can be concluded that the digital puzzle game media arithmetic operations material is valid and deserves to be tested on students.

4 Conclusions

The validation results by material and media experts assessment and interview above, the average result of an digital puzzle game media assessment obtained by material experts is 89,43%. While the average digital puzzle game media assessment by media experts is 91,64%. It can be concluded that the results of the digital puzzle game media assessment of material experts and media experts are classified as very worth it, which indicates that the digital puzzle game with arithmetic operations material application is categorized as feasible to be tested, according to the findings of the research and discussion of the issue. Based on the recommendations of media experts and subject matter experts, digital puzzle game media apps are suitable for usage by students are Kekancan Mukti kindergarten and IT Harapan Bunda kindergarten. These apps should include more exercise and display modifications animation to ensure that the maximum number of students can benefit from the media.

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