
THE DEVELOPMENT OF THE EDUCATIONAL GAME “FRACTION BAKERY”: AN ANALYSIS OF MEDIA ADVANTAGES FOR ELEMENTARY SCHOOL STUDENTS

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Abstrak: Penelitian ini bertujuan untuk mengembangkan game edukasi sebagai media pembelajaran matematika di tingkat sekolah dasar, khususnya pecahan. Dinamakan Fraction Bakery, game ini dikembangkan sebagai respon atas keluhan kesulitan siswa dan guru dalam belajar dan mengajar pecahan. Kesulitan ini, jika ditangani dengan buruk, dapat berfungsi sebagai masalah seperti gunung es untuk pemahaman mereka tentang konsep matematika yang lebih maju. Pengenalan bilangan, termasuk pecahan, merupakan dasar untuk belajar matematika. Sebagai seorang guru perlu mengevaluasi kesulitan belajar tersebut dan mencari alternatif media pembelajaran interaktif yang dapat dinikmati siswanya. Untuk tujuan penelitian, model penelitian dan pengembangan yang diusulkan oleh Thiagarajan, yang terdiri dari tahap Define, Design, Development, dan Disseminate, diterapkan. Game ini masih dalam proses pengembangan dengan mengevaluasi nilai media menggunakan uji coba respon yang melibatkan mahasiswa S1 Pendidikan Matematika Universitas Sebelas Maret. Mengenai antarmuka produk, 71% responden memberikan skor tinggi, 57% memberikan skor sangat tinggi pada animasi game, 75% menyatakan bahwa game akan memotivasi pengguna untuk belajar (dampak afektif), dan 57% menyatakan bahwa materi disampaikan dalam permainan sangat relevan dengan kompetensi.

Kata kunci : *Permainan edukasi, Fraction bakery, Pengembangan*

Abstract: This study aims to develop an educational game as a learning media for mathematics at the elementary school level, particularly fractions. Named Fraction Bakery, this game was developed as a response to complaints of students' and teachers' difficulty in learning and teaching fractions. This difficulty, if poorly addressed, may serve as an iceberg-like issue for their understanding of more advanced mathematic concepts. Number recognition, including fractions, is fundamental to learning mathematics. As a teacher, it is necessary to evaluate such learning difficulties and seek alternative interactive learning media their students can enjoy. For the purpose of the study, the research and development model proposed by Thiagarajan, consisting of Define, Design, Development, and Disseminate stages, was applied. This game was still in the development process by evaluating the media value using trial responses involving undergraduate students of mathematics education at Sebelas Maret University. Regarding the product's interface, 71% of respondents gave a high score, 57% gave a very high score to the game animation, 75% stated that the game would likely motivate users to learn (affective impact), and 57% stated that the materials delivered in the game are highly relevant to the competency.

Keywords: *Educational game, Fraction bakery, Development*

INTRODUCTION

Elementary school education aims to establish basic intelligence, knowledge, personality, noble character, and skills in order to live autonomously, be prepared for the advanced education level and provide students with skills to live in society. Regarding basic intelligence and knowledge, elementary education introduces and builds knowledge of a concept to students. Elementary education is also demanded to prepare students to live in society and to continue to the next education level. Satisfying such demands can be challenging, given elementary school students's cognitive level is still in the concrete operational stage. In other words, the learning material should be made as concrete as possible.

Teachers, in principle, serve as advocates of students' development to promote relatively consistent behavioral changes. To perform their functions, teachers need to have skills in planning and creating a supportive learning environment for students. Mathematics is one of the subjects students should master in elementary education.

Mathematics is one of the basic components of a learning process. It involves the calculation and thinking process required to solve problems. Basic mathematics, such as introduction to number concepts, is taught at the elementary school. However, the abstract nature of mathematics is sometimes difficult for students to understand as they learn new mathematical concepts, such as positive and negative integers, fractions, multiplication, division, and geometry. One of the concepts includes, for instance, explaining three-dimensional cubes as squares, sphere as a circle, and spelling 0.25. This study focuses on defining fraction operations, such as addition, subtraction, multiplication, and division.

During the elementary school teachers' professional education program, teachers mentioned several problems in fraction materials, including students misconceptions (adding numerator to numerator, denominator to denominator) $\frac{a}{b} + \frac{c}{d} = \frac{(a+c)}{(b+d)}$, when given comparison of two fractions like $\frac{1}{5} < \frac{1}{8}$, most students see that the higher the denominator, the larger the value, among other issues. The fraction materials are the important concept for more advanced levels. Based on the analysis, the student's difficulty in learning fractions lies in their need to see the form, fraction concept, and fraction operation in a real-life context, which could be facilitated by learning media.

In addition to the nature of the materials, the learning process in elementary education should also be designed to create a fun learning atmosphere, particularly for low-level students. Considering that learning and playing are among the students' needs, we attempted to develop an educational board game relevant to fractions. Board game is a type of game where game pieces are placed or moved on a game surface with certain signs based on a set of rules. (Wicandra & Astharianty 2017) Board game today has become one of the alternative educational media to attract students to socialize with their friends or families. As such, parents can monitor their children's learning progress and increase their children's

understanding of the materials in the game. The game materials are adjusted to a certain basic competence.

The board game developed in this study is named Fraction Bakery. It is designed as a means to train, think, and learn about fractions in enjoyable ways using designs that allow them to play while improving their understanding, as shown in levels 1-3. Educational game is designed to stimulate students' thinking skills, improving their concentration and problem-solving skill (Ridwan & Tresnawati, 2016). Educational game also serves as an effective interactive learning technique for preschool and elementary school levels because most children at this level exhibit high curiosity about their surroundings. Therefore, an educational game may serve as an appealing means of learning. Children significantly differed in understanding a material (Widoretno, Setyawan, & Muchlison, 2021). Fraction Bakery developed in this study is expected to serve as an alternative learning media to motivate them to learn fraction concepts autonomously with their parents. Therefore, a media evaluation involving several respondents was conducted to see whether Fraction Bakery met criteria of a good learning media in terms of contents and features.

RESEARCH METHOD

The educational game in this study was developed using ADDIE research and development, consisting of five stages: Analysis, Design, Development or Production, Implementation or Delivery, and Evaluations). This model was developed by Dick and Carry in 1996 to design a learning system (Endang Mulyatiningsih, 2014). This is a five-stage product development model beginning with need and material characteristics analyses (A: analyze), followed by designing the application and media prototype (D: design), developing the application storyboard, validating and revising the product, and analyzing the validity (D: development), implementing product pilot (I), and evaluating the product (E: evaluation).

The work reported in this paper was still in the Development stage. In this stage, media validation was conducted by involving several respondents. The respondents were undergraduate students of the mathematics education department of Sebelas Maret University who passed the Mathematic Learning Media course and finished the school internship program. Applying these criteria, respondents were assumed to understand student's on elementary school character. They also often spend their spare time playing game on their gadget, so we can assumed too, that they are familiar with many games and how to play the games, understanding the contents of the game about elementary school mathematic materials.

RESULTS AND DISCUSSION

This section presents the result of each stage in the ADDIE model:

1. Analysis

This stage involved the analysis of needs for new product development and its feasibility. The fraction material included the concept of fraction consisting of numerator and denominator, definition of fraction, fraction transformation, e.g., $\frac{1}{2} = \frac{2}{4}$, fraction comparison, and fraction operations.

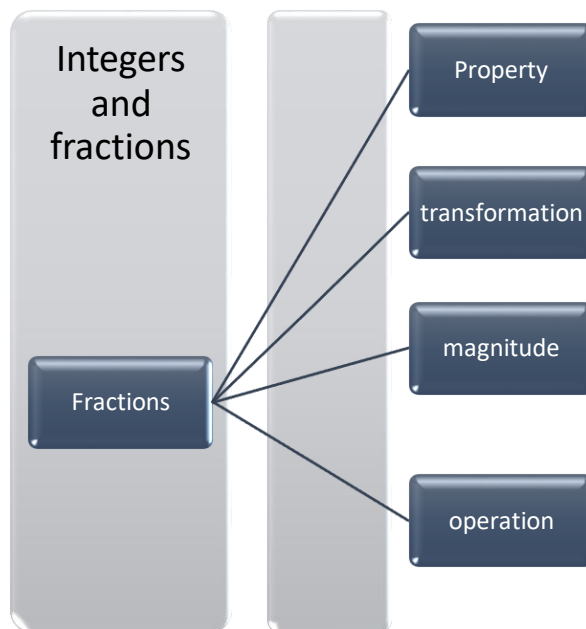


Figure 1. Fractions Analysis

Fraction materials are abstract, and most of 'real' examples are provided by teachers as a part of a whole ($=1$). The way to describe $\frac{2}{5}, \frac{3}{7}$ and other fractions with numerator other than 1 in a real manner, is still scarce. This condition causes misconception of fraction transformation, where students see $\frac{1}{2}$ and $\frac{2}{4}$ are two fractions with different values.

Children's interest in playing with their gadgets continues to increase nowadays, a phenomenon we attempt to leverage by developing an educational game. The development of the mathematical game, particularly on fractions, using Bahasa Indonesia and simple narration to stimulate children's reading skill is still limited. Therefore, we developed a board game by referring to fraction materials. It emphasizes the need for media to internalize concepts and allows students to learn the concept of fractions: Fractions as a part of a whole, fractions as operations, fractions as a division, fractions as

ratio, and fractions as a comparison. The board game was developed by considering the fact that technological advancement and children curiosity in playing games.

2. Design

In this stage, a prototype was developed using Unity with C programming language. It was a learning media for elementary education level focusing on describing the concept of fraction through storytelling and race game. The following is the home page of the game:

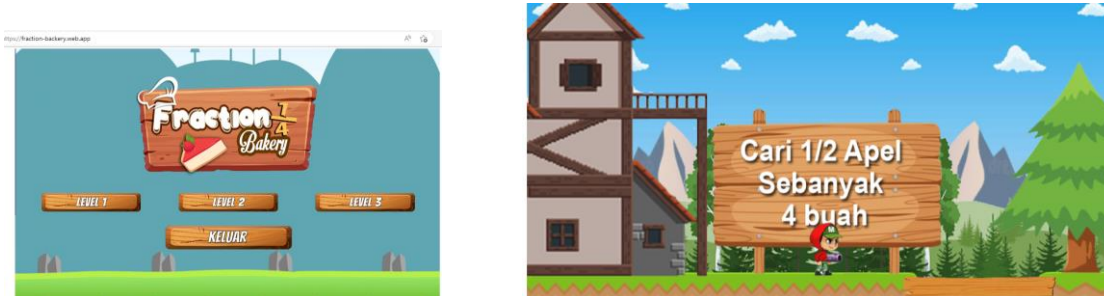


Figure 2. Prototype Design

It displays three levels designed in the game and narration asking players to seek several apples in the form of fraction. Level 1 is related to $\frac{1}{2}$ fraction, level 2 deals with $\frac{1}{3}$ fraction concept, and level 3 is related to $\frac{1}{4}$ fraction concept. This game ends when the game character fulfill the objectives stated in the instruction. For instance, in Level 1, the character is required to find four half apples, where students will understand the number of apples needed and locate half-cut apples. After that, students need to sum four half-cut apples to proceed to the next level. The game story is designed to continue to level 3.

3. Development

In this stage, the game was assessed by several trial users. They were undergraduate mathematic education students who had passed the Mathematic Learning media course, and conducted an internship. They were selected based on their interest in playing game and understanding of junior/senior high school students' character based on their teaching experiences.

The indicators of media value were assessed from several aspects as follows:

a. Interface

Interface is a product's visual appearance that connects users to the system. This was a web-based game. Its user interface, including shape, color, font, text quality, animation, audio, and visual aspects, is designed to be as attractive as possible. An attractive learning media may

significantly affect users' psychological aspects. The trial users' responses are presented as follows:

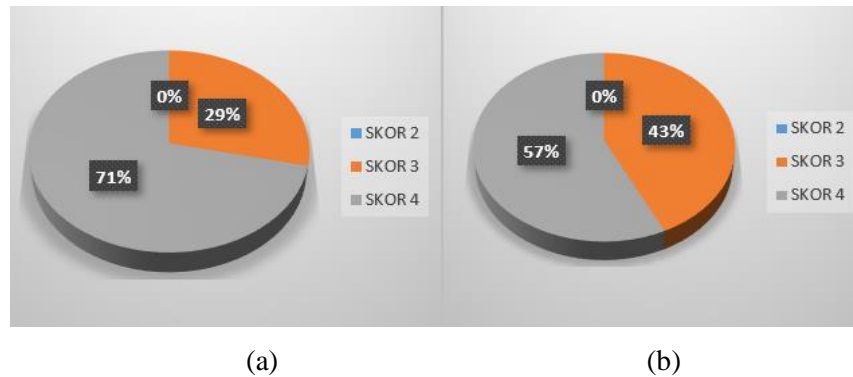


Figure 3. Questionnaire interface, (a) texts, colour, and audio, (b) animation use

b. Help Information.

This aspect is associated with respondent's responses to the game instruction and rules.

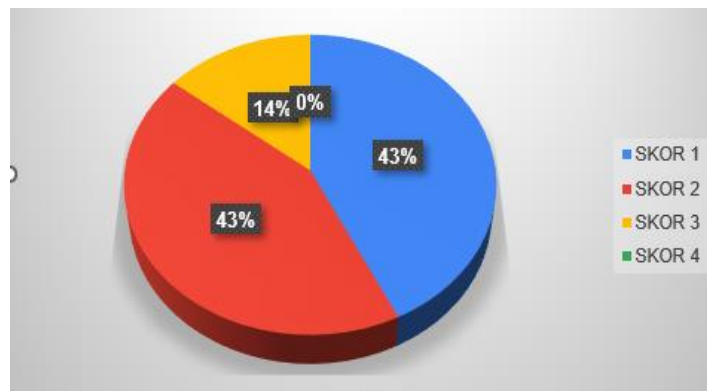


Figure 4. Game Information

Almost 86% of the respondents gave scores of 2 and 1 to this indicator, which was categorized as low. This serves as feedback for the developer to improve the game, particularly its home page. Although the narration is given on the home page, respondents stated that it is necessary to provide a thorough improvement at the game start.



Figure 5. Improvement Design After Feedback

c. Affective Impacts

Regarding this indicator, respondents responded to how the developed products motivated the users and provided an enjoyable learning-playing atmosphere.

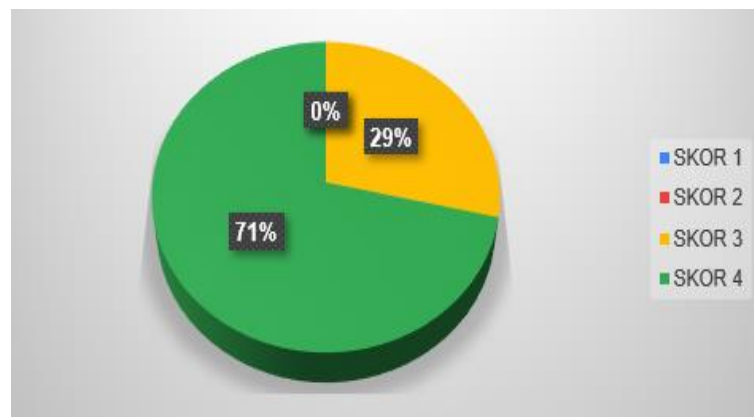


Figure 6. Affective Impact Questionnaire – happiness of learning

d. Material relevance.

This indicator deals with the game material relevance to the basic competence and the correctness of the materials. Although the result of this indicator exhibited a good percentage, it has not met the developers' expectations. This was probably caused by the response sheet that did not contain the conceptual framework of the materials.

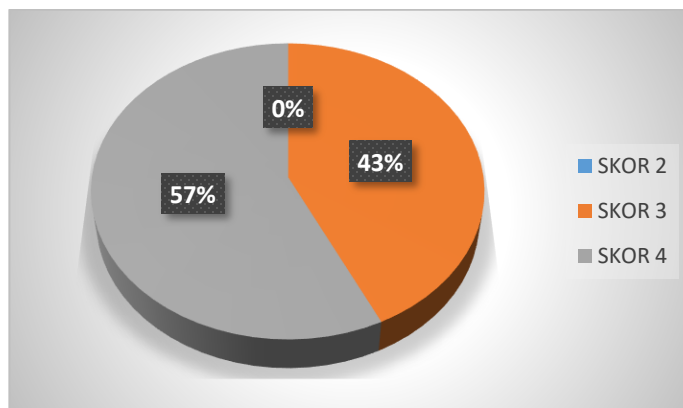


Figure 7. Material Relevance

While several improvements are necessary to enhance the developed game, its material is relevant to the competency requirement. In other words, the game is capable of delivering an enjoyable learning experience. Its affective impacts were also reported to be considered good.

The validation was performed using Aiken's V indices with significance level 0,05 and seven raters assessed four response choices. The validity scores are presented as follows:

Table 1. Validation Score

	Value	Conclusion
Interface : color, text and audio	0.87	Valid
Interface : animation	0.81	Valid
Help Information	0.30	Invalid
Affective Impacts	0.857	Valid
Material relevance	0.857	Valid

As shown in the Table 1, raters' assessment score of help information was very low, indicating needs for improvement/revision. The necessary revision included (1) instruction at the game start, (2) use of up-down buttons as a command button allowing the game character to jump. These buttons also needed to be put in adjacent so that they can be pushed together, (3), speeding up the game loading as the game loading was too long, possibly discouraging students from playing the game (in this case, learning through the game), and (4) applying different themes in each level to that the students perceive new challenges when moving to the next level.

CONCLUSIONS AND SUGGESTIONS

Following the user validation, which constitutes a phase in the development stage, the developed game, i.e., Fraction Bakery, had met all indicators of a good learning media in terms of interface, affective impacts, and material relevance. Fraction Bakery is an educational board game developed as a learning media to support elementary school students in learning mathematical fractions. The game's information need several improvements, including game instructions, additional buttons, and different themes for each level.

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