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DEVELOPMENT OF GEOMETRY EDU-GAME PETUALANGAN BARUDAK ORIENTED TOWARDS ETHNOMATHEMATICS OF BANTEN

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ABSTRACT

In the digital era, educational games have become one of the trends in utilizing technology for learning. However, integrating culture into educational games is a challenge to ensure that the culture is preserved and can support learning to be more contextual and meaningful. There are only a few studies on the development of ethnomathematics-based Edu-games. Therefore, this research focuses on developing an Edu-game oriented towards Banten ethnomathematics with the topics of 3D and 2D shapes. Using Research and Development, the ADDIE method is employed to develop this Edu-game. In the development stage of the Edu-game, validation was carried out by three content experts and three media experts by completing questionnaires and interviews. Subsequently, a trial of the Edu-game's use in learning was conducted in two elementary schools. A total of 35 students responded to the use of the game by completing questionnaires. As a result, the development of this Edu-game achieved an average percentage above 75% for each aspect, which means this Edu-game is "excellent". Thus, it can be concluded that the Edu-game "Petualangan Barudak" is suitable as a medium for teaching geometric shapes oriented towards the ethnomathematics of Banten.

***Keywords**: 2D, 3D, Culture, Learning Media*

ABSTRAK

Di era digital, permainan edukasi telah menjadi salah satu tren dalam memanfaatkan teknologi untuk pembelajaran. Namun, mengintegrasikan budaya ke dalam permainan edukasi merupakan tantangan untuk memastikan bahwa budaya tersebut dilestarikan dan dapat mendukung pembelajaran agar lebih kontekstual dan bermakna. Hanya ada beberapa studi tentang pengembangan Edu-game berbasis etnomatematika. Oleh karena itu, penelitian ini berfokus pada pengembangan Edu-game yang berorientasi pada etnomatematika Banten dengan topik bentuk 3D dan 2D. Dengan menggunakan Penelitian dan Pengembangan, metode ADDIE diterapkan sebagai tahap dalam pengembangan Edu-game ini. Pada tahap pengembangan Edu-game, validasi dilakukan oleh tiga ahli konten dan tiga ahli media melalui pengisian kuesioner dan wawancara. Selanjutnya, percobaan penggunaan Edu-game dalam pembelajaran dilakukan di dua sekolah dasar. Sebanyak 35 siswa memberikan tanggapan terhadap penggunaan permainan tersebut dengan mengisi kuesioner. Sebagai hasilnya, pengembangan Edu-game ini mencapai persentase rata-rata di atas 75% untuk setiap aspek, yang berarti Edu-game ini "sangat baik." Dengan demikian, dapat disimpulkan bahwa Edu-game "Petualangan Barudak" cocok digunakan sebagai media untuk mengajarkan bentuk-bentuk geometri yang berorientasi pada etnomatematika Banten.

***Kata Kunci:** 2D, 3D, Budaya, Media Pembelajaran*

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I. INTRODUCTION

In the digital era, education has undergone a significant transformation with the application of technology in the teaching and learning process (Dewi et al., 2023; Said, 2023). Technology enables access to broader and more easily reachable educational material. Through technology, students can learn from anywhere and anytime via online platforms, expanding learning opportunities beyond space and time constraints. In addition, technology also offers various interactive tools and applications that can enhance students' active engagement in learning, thereby increasing their interest in studying (Mulyawati et al., 2024; Said, 2023).

One of the trends in utilizing technology in education is educational games or Edu-games. Edu-games are games designed to stimulate thinking skills and are one way to train and enhance users' concentration (Arif & Dewi, 2016; Jumiati et al., 2023). Edu-games offer an interactive and enjoyable approach, allowing students to learn through hands-on experiences and simulations. Adrian & Apriyanti (2019) and Savitri et al. (2020) have researched and successfully developed an Android-based math Edu-game as an engaging and enjoyable medium for elementary school students in math learning. In addition, the research findings of Hawu et al. (2023) indicate that one of the benefits of using technology is that it can help students visualize geometric material, whether in three dimensions or spatial forms.

Visualization is included in the level of geometric thinking, with one of the indicators being the ability to identify shapes based on their appearance/form (Cesaria et al., 2021). The ability to think geometrically is an integral part of overall mathematical understanding. Geometry allows students to visualize and understand mathematical concepts, such as spatial relationships, patterns, symmetry, and transformations. Students may struggle to understand mathematical concepts thoroughly without strong geometric thinking skills. The ability to think geometrically is important in formal education and plays a crucial role in developing thinking skills and their application in various aspects of life (Ayuningtyas & Hakim, 2020). In reality, the mathematical abilities of Indonesian students are still considered low. According to the test results designed by the Organization for Economic Co-operation and Development (OECD), around 71% of students do not reach the minimum competency level in mathematics (Wulandari & Azka, 2018).

Geometry material requires a specific visual ability to understand it. Meanwhile, based on the findings of several researchers, there are still geometry lessons that only use conventional methods and lectures (Astrianingsih, 2015; Ayuningtyas & Hakim, 2020; Jumiati et al., 2023). In addition, other researchers also state that the lack of understanding among students in learning geometry is due to teachers not using teaching aids and not involving students' active participation in constructing their knowledge in mastering geometry (Cesaria et al., 2021). Although many studies show the benefits of using Edu-games in geometry material, there are still challenges in integrating

local content and culture into the design of educational games. Culture is closely related to Mathematics (Wahyuningtyas et al., 2020; Wewe & Kau, 2019). The study of the relationship between mathematics and culture is called Ethnomathematics (Ilham, 2023; Kencanawaty et al., 2020; Marsigit, 2016; Sianturi et al., 2022). Students can connect new concepts with their daily experiences and culture through an ethnomathematics approach, making learning more meaningful and contextual (Peni & Baba, 2019; Sugara & Mustika, 2018).

Based on these challenges, this research focuses on developing an Android-based Edu-game on the topics of three-dimensional and two-dimensional shapes oriented towards the ethnomathematics of Banten. The culture of Banten will be integrated into the geometric material, specifically in spatial and flat shapes, including buildings, tourist destinations, batik fabric, food, and the local wisdom of the Banten community. With this approach, it is hoped that students will find it easier to understand mathematical concepts through the cultural context of Banten while enhancing their awareness and love for their cultural heritage.

II. RESEARCH METHODS

This research aims to develop an educational game oriented towards Banten ethnomathematics about the geometry of three-dimensional and two-dimensional shapes. This research used a type of development research known as Research and Development (R&D) based on the ADDIE method, which stages of analyzing, designing, developing, implementing, and evaluating (Branch & Kopcha, 2014; Cahyadi, 2019; Dousay & Branch, 2022). In this development, all stages were revised until the created media was truly ready for implementation.

The data collection techniques used product validation instruments, questionnaires, and interviews. The materials, media, and student response instruments were adapted from Ayuningtyas & Hakim (2020). The aspects assessed in the material validation instrument consist of learning design, content, language, and the usefulness of the learning media. The aspects assessed in the media validation instrument include writing, images, design appearance, and the usefulness of the learning media. Furthermore, the aspects assessed in the student response questionnaire instrument are a combination of the two instruments for material and media, which include language, appearance, content, and the usefulness of the learning media (Ayuningtyas & Hakim, 2020).

The product validation instrument was given to three content experts and three media experts in media development. In addition, the developed game was tested on a small scale with 35 students from SDN Cigoong in Serang City. The students were selected based on purposive sampling techniques, where the samples were chosen carefully and were relevant to the research design (Creswell, 2015; Widodo et al., 2020). The product validation instrument and questionnaire were presented using a rating scale of 1 to 4 (Widoyoko, 2012). The rating scale was calculated by

determining the interval based on the maximum score (*Smax*), minimum score (*Smin*), and the number of interval classes (*k*) using the following formula.

$$Interval\ (i) = \frac{Smax - Smin}{k}$$

Sources: (Widoyoko, 2012)

An interval of 0.75 was obtained based on that formula. Thus, the classification for interpreting the survey results is as follows.

Table 1. Classification of Survey Result Interpretation

Average Score	Percentage (%)	Classification
> 3.25 s.d. 4.00	> 75 s.d 100	Excellent
> 2.50 s.d. 3.25	> 50 s.d 75	Good
> 1.75 s.d. 2.50	> 25 s.d. 50	Bad
1.00 s.d. 1.75	0 s.d 25	Extremely Bad

III. RESULTS AND DISCUSSION

The results and discussion in this research are explained based on the stages of the ADDIE development model as follows.

A. Analysis

The first stage is the analysis stage. In this phase, the researcher conducts a needs analysis. One of the needs analyses is the content requirement, which starts with the material that will be provided in product development. In the analysis of material needs, a literature review is conducted on the learning objectives, spatial, and flat shapes in lower-grade classes. Then, the content related to the culture in Banten is determined in connection with the material in spatial and flat shapes. In addition, an analysis was conducted to identify the problems faced and the needs required for the materials to achieve the learning objectives (Cahyadi, 2019; Tri et al., 2018). This analysis stage serves as a baseline for developing the product for the next stage (Mahardhika, 2015; Tri et al., 2018).

B. Design

The process of designing begins with determining the learning strategy or approach that will be used, followed by selecting the learning model and the evaluation questions that will be applied in the application (Cahyadi, 2019). After conducting an analysis of the objectives and materials, a flow and design for the game were created, starting from the content to the practice questions in the form of a game. The result of this stage is a design or plan that addresses the issues identified in the previous analysis and includes a strategy related to the learning that the application's users will gain next (Tri et al., 2018). The flow and flowchart for the children's adventure Edu-game are as follows.

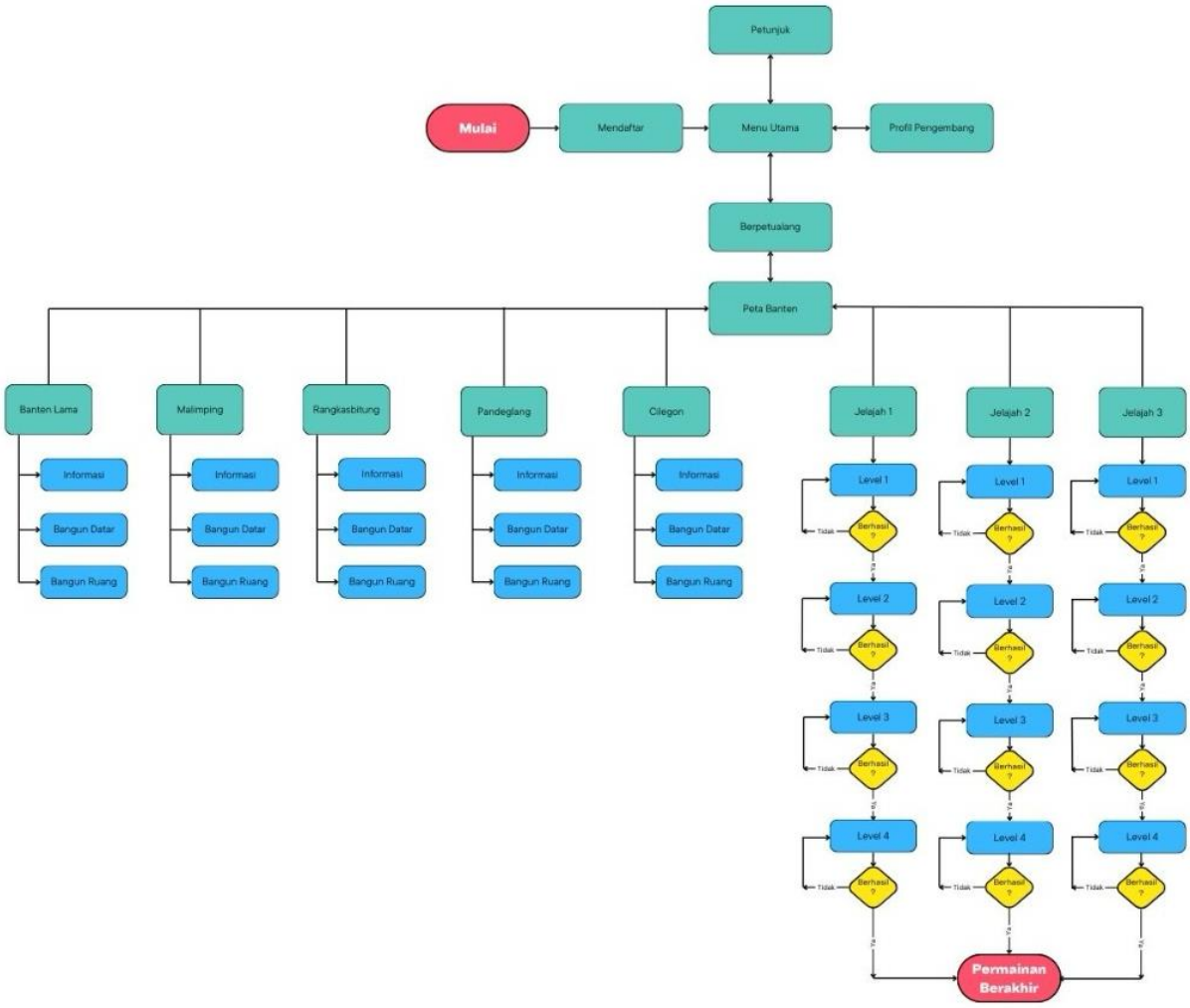

Figure 1. Flowchart of the Edu-game "Petualangan Barudak" oriented towards Ethnomathematics of Banten

C. Development

The next stage is the development phase of the Edu-game product, which includes designing various components such as materials, questions, and game rules, as well as the visual design that will be developed into software. During the development process, the product will be validated by competent experts in media and materials (Anggraini et al., 2021; Cahyadi, 2019; Kurnia et al., 2019; N. Wulandari, 2019). Revisions will be made if there are improvements and suggestions from the experts. The product will proceed to the implementation stage if it is deemed suitable.

The validator fills out the instrument validation that the researcher has created. The instrument validation consists of two categories: the material instrument validation and the media instrument validation. Three subject matter experts filled out the material instrument validation. Three material experts consist of one lecturer in mathematics education and two teachers from

different public elementary schools. The results of the expert validation are presented in table 2 as follows.

Table 2. Results of Expert Validation

Type	Assessment Aspect	Percentage	Classification
Material	Learning Design	92 %	Excellent
	Content Outline	88 %	Excellent
	Language	87 %	Excellent
	The Usefulness of Learning Media	89 %	Excellent
	Average	89 %	Excellent
Media	Writing	89 %	Excellent
	Image	86 %	Excellent
	Display Design	86 %	Excellent
	Product Use as Learning Media	98 %	Excellent
	Average	90 %	Excellent

Source: Researcher Data, **Date:** 2024

The results of the validation data processing for materials and media show an average percentage of 89% and 90%, which means that in terms of materials and media in product development, it falls under the interpretation of excellent. In the product development process, several improvements are based on feedback from the validator. One of them is that there is still the use of language that does not conform to the rules. The language used in learning media must pay attention to the correct language rules so students can easily understand it (Deni & Suratmi, 2024). In addition, the validator also provided feedback regarding the presence of signs indicating the parts of three-dimensional or two-dimensional shapes for better clarity. The positive aspect conveyed by the validator is that three-dimensional shapes can be manipulated based on the axis lines, which significantly helps students visualize these shapes. Agrees with Afriyana & Mampouw (2018), visual manipulation of three-dimensional shapes can assist students in imagining objects in images from different perspectives. This visualization ability plays a role in students' understanding or knowledge of geometric shapes in space. The educational game product has been revised based on feedback from the validators. The revised Edu-game product is presented as images/screenshots.

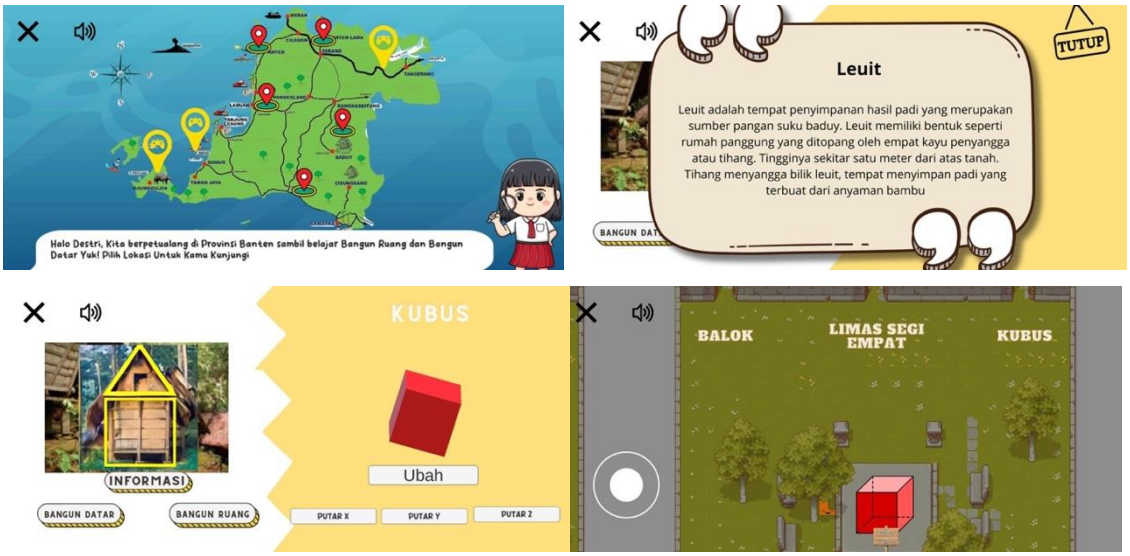

Figure 2. The Edu-game "Petualangan Barudak" Oriented towards Ethnomathematics of Banten

D. Implementation

The implementation stage in this research is the step to implement the developed product in a real classroom situation (Cahyadi, 2019). The product will undergo a small-scale trial with research subjects, specifically 35 elementary school students from SDN Cigoong in Serang City. Edu-game is implemented during the learning process as a medium for education. Through Edu-games, students become familiar with three-dimensional and two-dimensional shapes based on the cultural context presented in the materials of the Edu-games. Furthermore, besides displaying the material in the Edu-game, there are practice questions in games where users are given images and must select the correct answer to proceed to the next question. After the students participated in the mathematics lesson on three-dimensional and two-dimensional shapes using the Edu game, they filled out a questionnaire to gauge their responses to using the Edu game.

E. Evaluation

The formative evaluation at this stage aims to assess the quality of the game that has been developed. Feedback from students was obtained through small group trials regarding the usefulness or practicality of using the game. This formative evaluation is very important to measure how much the learning product has met the expected quality standards and identify areas that need improvement. In the final stage, it will become a report on the system testing results (Lankoski & Björk, 2015; Tri et al., 2018). Thus, this stage ensures that the developed product is ready to be effectively used in the school learning context, providing maximum user benefits. The results of the students' responses from the trial are presented in table 3 below.

Table 3. Results of the Edu-game Trial

Assessment Aspect	Percentage	Classification
Language	81 %	Excellent
Appearance/Learning Design/Display	80 %	Excellent
Content Outline	82 %	Excellent
The Usefulness of Learning Media	90 %	Excellent
Average	83 %	Excellent

Based on table 3, the data processing results from student responses in the trial using the Edu-game show an average percentage of 83%, interpreted as excellent. In addition, based on the interviews, students explained that their knowledge increased with the integration of Banten culture in learning three-dimensional and two-dimensional shapes. This result is in line with the research conducted by Suandi et al. (2023), which significantly improved students' understanding of questions about cultural heritage. Students' understanding of mathematics and culture has improved after education on integrating culture into mathematics. Additionally, as shown by research conducted by Peni & Baba (2019) and Sugara & Mustika (2018), learning that connects new concepts with everyday experiences and their culture will be more meaningful and contextual.

IV. CONCLUSIONS AND SUGGESTIONS

A. Conclusions

Based on the research and development results of the Edu-game "Petualangan Barudak" oriented towards Banten Ethnomathematics, the interpretation of the validation of the material and media is rated as excellent. The Edu-game includes material on several cultures of Banten, ranging from art and architecture to food, which is linked to three-dimensional and two-dimensional shapes. One of the advantages of this game is that it features a visualization of three-dimensional shapes that can be rotated along axes, helping students to imagine the forms of these shapes from various perspectives. The use of Edu-games has been tested in learning. The student response data processing results indicate that the Edu-game's development is already excellent. Based on this, it can be concluded that the Edu-game "Petualangan Barudak" development is excellent and can be used as a learning medium for geometry material.

B. Suggestions

Suggestions for further research include research related to additional features, such as Augmented Reality (AR) in Edu-games, to help students' visualization abilities. Some game developers may also integrate other features, such as quizzes, into the game. Teachers must be able to follow technological developments when planning learning media.

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