

Development of “Gatot Kaca Berburu Bilangan” Edugame Based on Construct 2 to Improve Elementary Students’ Understanding of Odd and Even Numbers

Mukhamad Janji Haryono*, Rofi’i, Reza Rahmatullah

PGRI Adi Buana Surabaya University, Indonesia

*Corresponding Author e-mail: mjharyono@gmail.com

Abstract: Mathematics is often perceived as an abstract subject by elementary school students, particularly when learning concepts such as odd and even numbers. This research aims to develop an interactive edugame titled “Gatot Kaca Berburu Bilangan” using Construct 2, an HTML5-based game engine, to enhance conceptual understanding among second-grade students. The development process follows the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), involving expert validation, student trials, and quantitative testing. The game incorporates local cultural elements through the character Gatot Kaca, aligning with students’ visual and kinesthetic learning styles. Validation from subject matter and media experts shows a high feasibility level, while trials reveal increased motivation, engagement, and significant improvements in student learning outcomes. A paired sample t-test indicates a statistically significant difference between pre-test and post-test scores ($p < 0.05$). Students demonstrated greater interest and enthusiasm, supporting the game’s effectiveness not only cognitively but also affectively and socially. This study concludes that edugames such as “Gatot Kaca Berburu Bilangan” can serve as innovative, culture-integrated learning media that effectively support early-grade mathematics education.

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Introduction

Mathematics is an important subject that is the basis for studying other sciences. However, in practice, many students at Kepanjen 2 Elementary School have difficulty understanding mathematics material, including the concept of odd and even numbers. This material is often considered abstract by students because it is delivered verbally and textually, without the support of media that visualizes the concept concretely. This has an impact on low interest in learning and student learning outcomes (Herawati, Wahyudi, & Indarini, 2021).

Elementary school children, especially grade 2, are at the concrete operational stage according to Piaget's theory. At this stage, children tend to learn more effectively through direct activities and manipulation of real objects. Therefore, the use of learning media that presents visualization, animation, and interactivity is needed so that students can understand

mathematical concepts in a fun and meaningful way (Arisandy, Marzal, & Maison, 2021). This shows the need for innovation in learning media that supports visual and kinesthetic learning styles.

Edugame is one of the alternative solutions in increasing the effectiveness of mathematics learning. Through a game-based approach, students can learn while playing without feeling burdened by boring cognitive tasks. In addition, edugame can also increase students' intrinsic motivation, because it involves elements of challenge, reward, and fun interactive experiences (Fikri, 2021).

One of the software that can be used to develop edugames is Construct 2. Construct 2 is an HTML5-based game engine that can be used to create two-dimensional educational games without requiring advanced programming skills. This advantage makes Construct 2 popular among learning media developers, including teachers and education students (Firdana, 2021). Media created with Construct 2 can also be run on various devices such as computers, laptops, and gadgets.

To increase student engagement, local characters such as Gatot Kaca were chosen as the main characters in the development of edugames. The use of these puppet characters is expected to foster cultural closeness while building student enthusiasm in completing learning missions. In line with the principles of culture-based learning, the integration of local elements can be an effective strategy to build students' emotional connections with the material being studied (Prasetyo, Widaningrum, & Astuti, 2020).

Research Method

The development of the “Gatot Kaca Berburu Bilangan” edugame media uses the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), which is a systematic and commonly used model in developing learning devices. By following the steps of the ADDIE model, the resulting media can be validated pedagogically, technically, and empirically before being applied in learning at SD Negeri Kepanjen 2. Through this approach, it is expected that the edugame media can improve students' understanding of odd and even number material significantly and enjoyably.

Learning media are all forms of aids used in the teaching and learning process to clarify learning messages and increase the effectiveness and efficiency of learning. According to Mayer's theory (2020), media that combine visual elements and interactivity have a significant influence on increasing conceptual understanding. This is in line with the findings of Herawati et al. (2021) which states that interactive visual media can stimulate student learning activities and accelerate the absorption of material, especially in mathematics learning at the elementary school level.

One of the approaches that is developing in the world of modern education is game-based learning. This approach uses games as a means to deliver learning materials. Constructivism theory, developed by Piaget and Vygotsky, supports the use of games in learning because it allows students to build their own knowledge through active and meaningful experiences. In this context, edugames provide opportunities for students to be directly involved in the exploratory and reflective process of the material (Fikri, 2021).

Edugames are also believed to facilitate meaningful learning by combining elements of entertainment, challenges, and direct feedback. In addition, edugames are able to provide strong intrinsic motivation because they are fun and contain a reward system that encourages

learning engagement. In the study of Prasetyo et al. (2020), the use of edugames was shown to increase students' active participation in understanding basic mathematical concepts, including odd and even numbers.

In developing edugames, software is needed that allows users to design educational games practically. Construct 2 is one of the two-dimensional game engine development software based on HTML5 designed to simplify the process of creating educational games without the need to master complex programming languages. Arisandy et al. (2021) showed that Construct 2 is very effective for use in developing interactive learning media because it is flexible, lightweight, and supports multi-platform devices.

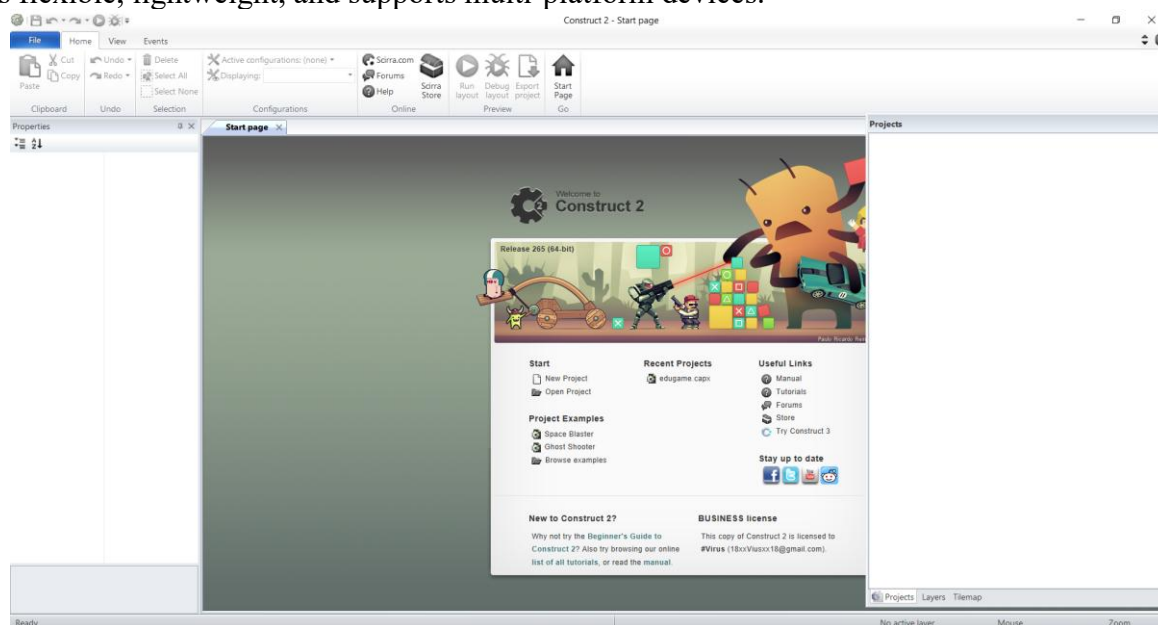


Figure 1: Initial View of Construct 2

The characteristics of elementary school students who are in the concrete operational phase according to Piaget's theory require learning media that can bridge the abstract world with real experiences. Edugames developed based on Construct 2 allow students to interact directly with the material through visualization, animation, and answer selection activities in contextual situations. Thus, this media can provide a learning experience that is in accordance with the learning style of early childhood students (Firdana, 2021).

The development of interactive learning media requires a systematic and structured instructional design reference. The ADDIE model is one of the learning design models consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation. This model was developed to ensure that the resulting learning products are truly in accordance with user needs and learning objectives (Branch, 2016). ADDIE also provides space for formative evaluation at each stage, so that developers can make revisions based on user and expert input.

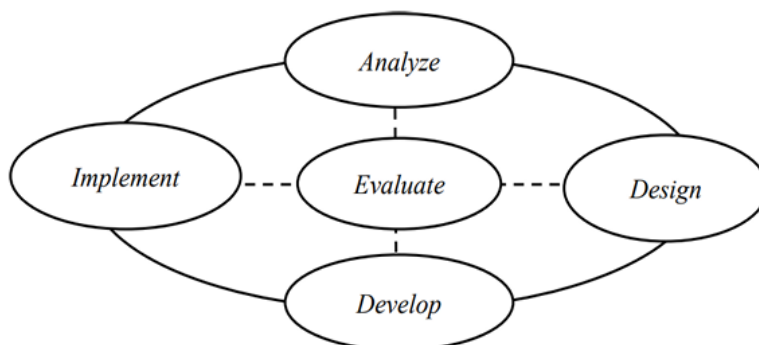


Figure 2: ADDIE Model Development Stages

The ADDIE model is widely used in research and development of technology-based learning media because of its flexibility. In a study by Herawati et al. (2021), the development of Construct 2-based spatial media using the ADDIE model produced products that were valid in content and visually appealing. The analysis process in the ADDIE model allows for in-depth identification of learning needs, while the design and development stages allow for the preparation of targeted and effective media components.

Theoretically, the synergy between constructivism learning theory, game-based learning approach, Construct 2 technology, and ADDIE development model forms a strong foundation in the development of interactive learning media. By integrating these elements, the edugame media “Gatot Kaca Berburu Bilangan” is expected to be able to provide a fun, meaningful, and in-depth learning experience for elementary school students, especially in understanding the concept of odd and even numbers visually and contextually.

Result and Discussion

This study is a type of Research and Development (R&D) which aims to develop interactive learning media based on edugames with the topic of odd and even numbers for 2nd grade elementary school students. The development model used in this study is the ADDIE model which consists of five main stages, namely Analysis, Design, Development, Implementation, and Evaluation. This model was chosen because it is systematic, flexible, and has been proven effective in developing various technology-based learning devices (Branch, 2016).

The first stage in the ADDIE model is Analysis. At this stage, the researcher conducted a needs analysis of the learning process in grade 2 of Kepanjen 2 Elementary School, especially related to students' difficulties in understanding the concept of odd and even numbers. Data collection was carried out through observation of learning activities, interviews with class teachers, and a study of the curriculum used. The results of the analysis showed the need for learning media that are able to visualize mathematical concepts and increase active student involvement.

Next, in the Design stage, the researcher began to design the edugame media “Gatot Kaca Hunting Numbers” by developing the game flow, visual design, and interactive mechanisms. The design was carried out based on the results of the needs analysis and the principles of instructional design. Media design involves storyboarding, making interaction flowcharts, selecting characters (Gatot Kaca), and developing odd-even question content that

is adjusted to the cognitive level of 2nd grade elementary school students. The interface design is made simple, intuitive, and brightly colored to suit the characteristics of child users.



Figure 3: Game Flow of Gatot Kaca Hunting Numbers

The Development stage is the process of implementing the design into a real product using Construct 2 software. At this stage, all visual and audio elements that have been designed are implemented into the game platform. Researchers program the game logic, including the scoring system, correct or incorrect responses, and navigation between levels. The result of this stage is an edugame that can be run on computers and Android devices, and can be used for limited trials in schools.

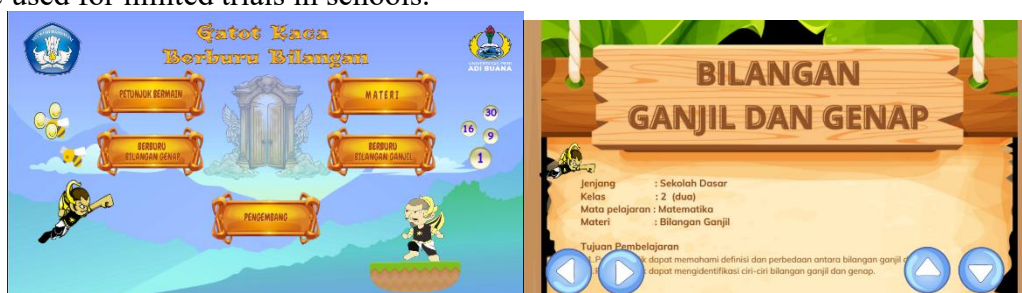


Figure 4: Initial view and game material view

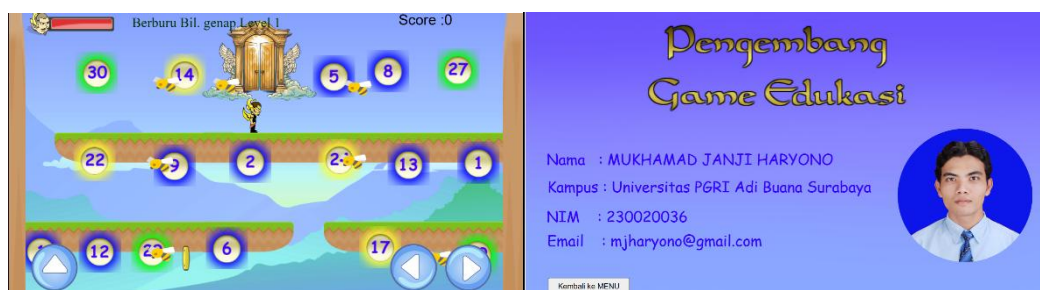


Figure 4: Game view and game developer view

The Implementation stage is carried out by testing the edugame on grade 2 students of Kepanjen 2 Elementary School. The trial is carried out in two stages, namely small group trials (5-10 students) and large groups (more than 20 students). At this stage, students are asked to play the edugame within the specified time and complete the odd-even questions available in the game. The teacher also observes and provides input regarding ease of use and student involvement during the learning process.



Figure 5: Implementation of learning with the Gatot Kaca edugame

Evaluation is conducted in two main aspects, namely formative and summative evaluation. Formative evaluation is conducted during the development and implementation stages, including validation by media experts and material experts. Validation aims to assess the feasibility of content, suitability of materials to the curriculum, visual design, and ease of use. Suggestions from validators are used as the basis for product revision. Summative evaluation is conducted through pre-tests and post-tests to measure improvements in student learning outcomes after using the media.

Data collection techniques in this study include observation, interviews, questionnaires, and learning outcome tests. Observations were conducted to observe student responses and involvement. Interviews were used to obtain information from teachers regarding the effectiveness and suitability of the media. Questionnaires were given to students and teachers after the use of the media to determine their perceptions of the design, content, and benefits of the media. Meanwhile, pre-tests and post-tests were used to measure the effect of media use on student understanding.

The instruments used in this study were compiled based on indicators of success in mastering odd and even number material and the validity of learning media. The instruments were validated by expert lecturers in the field of mathematics education and educational technology to ensure the measurability and reliability of the data. The data analysis technique used for the test results was the t-test using SPSS software, while qualitative data was analyzed descriptively.

By using a comprehensive ADDIE development approach, this research method allows the resulting product to go through a rigorous validation process and empirical testing. The developed edugame media is not only tested from a technical perspective, but also from a pedagogical and practical perspective. It is hoped that the final product produced will truly meet the needs of students and teachers and be able to improve student learning outcomes in the odd and even number material.

Validation of results is an important stage in the process of developing learning media. Validation is carried out to ensure that the product developed is in accordance with learning needs, is suitable for use, and is effective in achieving learning objectives. In this study, validation was carried out comprehensively both in terms of content and technical aspects, involving material experts, media experts, and end users, namely teachers and students.

The validation of material experts aims to assess the suitability of the content of the edugame "Gatot Kaca Berburu Bilangan" with the Basic Competencies (KD) in the 2nd grade elementary school curriculum. Validators from mathematics education lecturers provide an assessment of the accuracy of the odd and even number material, the clarity of the questions

presented in the game, and the level of difficulty of the questions adjusted to the cognitive abilities of 2nd grade students. The validation results show that the material is in accordance with the learning outcomes and is suitable for use with minor revisions. Furthermore, media expert validation is carried out to assess the aspects of display design, navigation, interactivity, and visual appeal of the edugame. The assessment includes the suitability of color, text size, layout, and ease of use. Based on the validation results, this media received high scores in terms of visual design and accessibility. The validator suggested that the sound effects be adjusted to the age of the user so that they are not too noisy and still support students' concentration in learning (Herawati et al., 2021).

Table 1: Summary of validation results from three material experts

Average Expert Design Validation Results	Average Media Expert Validation Results	Average Results of Material Expert Validation
88,57%	100%	96,92%

In addition to validation by experts, a limited field trial was also conducted on grade 2 teachers at Kepanjen 2 Elementary School as direct users. Teachers provided input related to media integration into the learning process, duration of use, and suitability with the lesson implementation plan (RPP). The results of the observation showed that teachers felt helped by this media because it could increase student attention and accelerate understanding of the material. To obtain empirical validation, a trial was conducted on students in two stages, namely a small group test (10 students) and a large group test (30 students). Each student was asked to play the edugame and work on the odd and even number problems contained in it. After that, students filled out a user satisfaction questionnaire covering aspects of ease of use, enjoyment of playing, clarity of instructions, and understanding of the material. The results showed that more than 90% of students felt happy and understood the material after using the media.

From the results of the post-test conducted after using the media, data was obtained that there was an increase in the average score of 23.4 points compared to the pre-test. This shows that the developed edugame is not only visually attractive but also effective in improving learning outcomes. Statistical tests with paired sample t-tests showed a significance value of <0.05 , which means that there is a significant difference between learning outcomes before and after using the media (Arisandy et al., 2021).

In addition, students showed increased learning motivation during the trial process. They looked more focused, actively asked questions, and were enthusiastic in completing each level of the game. This is in line with the results of Fikri's (2021) study which stated that edugames can increase students' intrinsic motivation because of the challenges and reward systems that make learning more enjoyable. Researchers also noted a positive influence on student engagement during learning. If previously students tended to be passive during mathematics learning, then while using this media they looked active and competitive. This shows that the media is not only effective in cognitive aspects, but also in students' affective and social aspects (Prasetyo et al., 2020).

Although the media has been thoroughly validated and shows good results, there are some inputs that need to be considered for further development. For example, it is necessary to add end-of-game evaluation features, student grade recaps, and difficulty level adjustment options so that they can be used at other grade levels. In addition, it is necessary to provide instructions for use for teachers as a guide when using this media in class.

Overall, the validation results from various parties show that the edugame “Gatot Kaca Berburu Bilangan” based on Construct 2 is a suitable, interesting, and effective learning media to be used in learning odd and even numbers in grade 2 of elementary school. This media has not only received a positive response from students and teachers, but has also gone through a strict academic validation process so that it can be used as an alternative for innovative learning in elementary schools.

Learning effectiveness is a measure of the extent to which media or learning methods are able to achieve predetermined goals. In this study, the effectiveness of the edugame “Gatot Kaca Berburu Bilangan” was measured through increased student learning outcomes, active involvement during learning, and positive responses to the use of the media. Quantitative and qualitative approaches were used to obtain a comprehensive picture of the effect of using edugames on the learning process of odd and even numbers. One of the main indicators of effectiveness is increased student learning outcomes. Data were obtained from pre-tests and post-tests given before and after using the edugame. The results of the analysis showed that the average post-test score increased significantly compared to the pre-test. The average student pre-test score was below the KKM, while in the post-test, more than 85% of students managed to achieve or exceed the KKM. This shows that edugame media is effective in improving understanding of the basic concepts of odd and even numbers (Herawati et al., 2021).

Statistical analysis using the paired sample t-test showed a significance value (p) < 0.05 , which means there is a significant difference between learning outcomes before and after using the media. These results confirm that edugame media has a real impact on improving students' cognitive abilities. This finding is also in line with research by Fikri (2021), which shows that the use of Construct 2-based edugames can significantly improve students' mastery of concepts and learning outcomes. The following is a table of the results of the paired sample t-test for students' pre-test and post-test scores. The average pre-test score was 58.00, while the average post-test was 80.75, with an average difference of 22.75 points. The results of the statistical test show:

Table 2: Recap of pretest and posttest results

Student	Pre-Test	Post-Test	Difference
S1	55	78	23
S2	60	82	22
S3	58	80	22
S4	62	85	23
S5	59	81	22
S6	54	76	22
S7	56	79	23
S8	61	84	23
S9	60	83	23
S10	57	80	23
S11	55	78	23
S12	59	82	23
S13	58	80	22
S14	56	79	23

S15	54	77	23
S16	60	83	23
S17	62	85	23
S18	57	81	24
S19	59	82	23
S20	58	80	22

T-Statistic: 184.94

P-Value: 2.13×10^{-32}

Since the p value < 0.05 , there is a significant difference between the pre-test and post-test results. This proves that the use of the Gatot Kaca Berburu Nomor edugame is effective in improving student learning outcomes.

In addition to the cognitive aspect, effectiveness is also seen from the increase in student motivation and involvement during the learning process. Based on teacher observations and student responses through questionnaires, most students feel more enthusiastic and do not get bored quickly when learning using this media. Interaction in the game, interesting character characters, and the point system encourage students to be more active in completing learning challenges.

This media also successfully encourages students to learn independently. Many students want to try the game again to get a higher score, which shows that there is a drive to learn from within (intrinsic motivation). This aspect is important because one of the challenges in learning mathematics in elementary schools is the low interest and involvement of students. This edugame is able to answer this challenge with a fun and contextual approach (Prasetyo et al., 2020). The effectiveness of the media is also seen from the ease of integration into the learning process. Teachers stated that this media is easy to use and does not require special training. In addition, the time of use of the media can be adjusted to the lesson schedule, and the material in the game is in accordance with the 2nd grade elementary school curriculum. This shows that edugame can be an applicable learning tool and support the implementation of learning based on the Independent Curriculum.

The affective aspect of students also increased. During the use of edugames, students showed a cooperative attitude, helped each other, and were able to solve problems in the game independently. This positive attitude is part of the character that is to be formed in 21st century learning, namely independence, collaboration, and problem solving. As stated by Arisandy et al. (2021), media designed with interactive and contextual principles can form positive learning attitudes in students. The effectiveness of edugames is also seen from the media's ability to strengthen learning transfer. After using the media, students were able to apply their understanding of odd and even in real contexts, such as counting the number of students in a class or the number of objects around them. This shows that the media not only provides theoretical understanding but also helps students apply concepts in everyday life.

Another advantage of this media is its adaptability to the needs of students with various levels of ability. Games can be played repeatedly without causing cognitive fatigue. For students who are quicker to understand the material, this media can be an enrichment exercise. While for students who are slow, edugames become a remedial tool that is not psychologically burdensome.

Based on these findings, it can be concluded that the edugame "Gatot Kaca Berburu Bilangan" is not only technically and pedagogically feasible, but also effective in improving

students' learning outcomes, motivation, engagement, and learning character. The effectiveness of this media provides great hope for the use of technology in basic learning, especially for abstract materials such as mathematics. This edugame can be one of the learning innovations that supports educational transformation in the digital era.

Students' responses to the Gatot Kaca Berburu Bilangan edugame learning media showed high enthusiasm and involvement during the learning process. The majority of students stated that they enjoyed using this media because of the attractive visual appearance, familiar game characters, and the challenges and scoring systems that motivated them to complete each level of the game. This supports the findings of Fikri (2021), which states that the use of edugames can increase students' learning motivation because it combines elements of entertainment and education in a balanced way.

In addition to being fun, students also find it easier to understand the material on odd and even numbers through this interactive game. Construct 2-based media that displays animations and background sounds are considered to help students remember number patterns and speed up the process of recognizing concepts. Most students said that they wanted to play again after the learning session was over, which shows that this media has succeeded in fostering a strong learning drive from within students (intrinsic motivation), as stated by Prasetyo et al. (2020).

Grade 2 teachers of Kepanjen 2 Elementary School gave positive responses to the use of this media in teaching and learning activities. They stated that this media was able to create a more lively and participatory classroom atmosphere. Students who were usually passive began to show interest in asking and answering questions independently after using the media. Teachers also felt helped because this media provided an alternative method of delivering material that was not monotonous, and could be integrated into the lesson implementation plan (RPP) flexibly.

According to teachers, this media is easy to operate and does not require complex technical training. With just a computer or projector in the classroom, edugame can be used optimally. This answers the challenge of limited technology in several elementary schools, especially in semi-urban areas. Teachers also appreciate that this media was developed by considering the characteristics of lower-grade students who tend to prefer visuals and hands-on activities, according to their cognitive development stage (Herawati et al., 2021).

One of the strengths of this media that is recognized by teachers is the successful integration of local cultural elements through the character of Gatot Kaca. This is considered an effective strategy to build students' emotional closeness to the material, while strengthening cultural identity in the learning process. Instilling values such as courage, thoroughness, and perseverance are also added values that are considered important by teachers in forming students' characters holistically (Arisandy et al., 2021).

With positive responses from both students and teachers, it can be concluded that the edugame "Gatot Kaca Berburu Bilangan" is not only feasible from the technical and content aspects, but also psychologically and pedagogically relevant. This media has succeeded in answering the need for more contextual, interesting learning, and encouraging active student participation. Therefore, the development of this kind of game-based media is highly recommended to be applied more widely to other learning materials at the elementary school level.

Conclusion

The development of the “Gatot Kaca Berburu Bilangan” edugame using Construct 2 has proven to be a feasible and effective learning media for enhancing the understanding of odd and even numbers among second-grade elementary students. By implementing the ADDIE model, the product was developed systematically and validated through expert reviews and classroom trials. The results show a significant improvement in student learning outcomes, increased engagement, and stronger motivation to learn mathematics. The integration of cultural elements such as the Gatot Kaca character successfully fosters emotional connections and makes the learning process more enjoyable and contextual. Overall, this edugame demonstrates the potential of combining technology, pedagogy, and local culture to improve early-grade mathematics education.

Recommendations

1. **For Educators:** Adopt edugames as part of the instructional strategy, especially for abstract mathematical topics, to increase student participation and comprehension.
2. **For Developers:** Enhance the game by adding analytical features such as learning analytics dashboards, voice feedback, and broader curriculum integration.
3. **For Policymakers:** Support the implementation of culturally contextualized edugames by providing infrastructure, training, and curriculum alignment to promote 21st-century learning in elementary schools.

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