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# Media Development of Runner Mathematics Educational Game Based on Website Using Unity on Simple Fraction Material 5th Grade Elementary School

**Hanifah Nur Azizah[1*], Kusmajid Abdullah[2]**
[1*,2]Primary School Teacher Education Study Program, Universitas Muhammadiyah Prof. Dr. HAMKA
Jl. Tanah Merdeka No. 20, Jakarta Timur, Indonesia
[1*]nifaahazizah0812@gmail.com; [2]cak_kuze@uhamka.ac.id

**ABSTRAK**

Rendahnya minat dan hasil belajar siswa pada materi pecahan sederhana di kelas 5 SD menjadi dasar pengembangan media pembelajaran yang inovatif. Penelitian ini bertujuan untuk mengembangkan game edukasi Runner Mathematics berbasis website menggunakan Unity dengan model ADDIE. Data dikumpulkan melalui observasi, angket validasi ahli, dan angket respon siswa, kemudian dianalisis secara deskriptif kuantitatif. Hasil penelitian menunjukkan bahwa media ini layak digunakan dan mampu meningkatkan motivasi dan keterlibatan siswa. Game ini berpotensi menjadi media pembelajaran matematika yang interaktif dan mudah diakses.

**Kata Kunci**: Game edukasi; interaktif; matematika; pengembangan media; Unity

**ABSTRACT**

The low interest and learning outcomes of students in 5th-grade elementary school regarding simple fractions are the basis for the development of innovative learning media. This research aims to develop a website-based Runner Mathematics educational game using Unity with the ADDIE model. Data were collected through observation, an expert validation questionnaire, and a student response questionnaire, and then analysedanalysed both descriptively and quantitatively. The results show that this media is feasible to use and can increase student motivation and engagement. This game has the potential to be an engaging and accessible medium for learning math.

**Keywords**: Educational game; interactive; mathematics; media development; Unity

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## 1. INTRODUCTION

Mathematics plays an important role in the education curriculum as the basis for developing critical, logical and analytical thinking skills, as well as problem-solving skills that are very important for students (Rahmawati et al., 2024; Suwanto et al., 2025). A strong mastery of mathematics, especially at the elementary school level, is inevitable because the basic principles of mathematics become a crucial foundation to support learning in various other disciplines.

Moreover, mathematics has broad practical relevance in everyday life, from simple calculations when shopping to understanding the concepts of space and time that make it possible to navigate the environment effectively. As part of basic education, mathematics learning also plays a role in shaping students' disciplinary and responsible character, in accordance with the educational values instilled early in school (Azzahra & Irawan, 2023). However, the reality on the ground often shows that math learning is considered a difficult, abstract, and confusing subject for many students.

This negative perception is particularly prominent in fraction materials, which demand deep conceptual understanding and complex computational skills, including mastery of fraction addition, subtraction, multiplication and division operations. The complexity of this fraction material underscores the need for innovative and effective learning approaches, by applying methods that are more concrete, visual and relevant to students' daily experiences, with the main goal of bridging the understanding gap and changing students' perceptions of mathematics to be more positive and interesting (Slameto, 2013; Fitriya, Kurniawan, & Latif, 2023).

Slameto (2013) defines interest in learning as a sense of preference and a sense of interest in a matter or activity related to a particular object or learning activity. This interest comes from within the individual without any coercion or pressure from outside. Low interest in learning is an important problem in education because it has a major impact on students' motivation and desire to be actively involved in the learning process. Lack of deep understanding of mathematical concepts, in particular, can lead to decreased interest in learning which ultimately affects students' overall learning outcomes.

Various factors contribute to this problem, including the use of conventional learning methods that tend to be boring and less able to excite students. The lack of variety and attractiveness of learning media also exacerbates the situation. In fact, many mathematics teachers still use direct instruction methods, which focus more on memorizing formulas and procedures without giving enough emphasis on deep concept understanding (Legina & Sari, 2022). As a result, students have difficulty connecting mathematical material with applications in everyday life, which leads to boredom and loss of interest, and has a negative impact on students' overall academic performance (Haptanti et al., 2024).

In addition to facing challenges in understanding abstract mathematical symbols, complex formulas, and the many concepts that must be mastered in a short period of time, students also often face psychological difficulties that trigger fear and dislike of mathematics, which has a negative impact on their overall motivation to learn (Efwan et al., 2024).

In fact, mathematics plays an important role in forming a scientific and analytical mindset, an ability that is needed for the advancement of technology and science in this increasingly competitive era of globalization. Recognizing this importance, the development of digital technology opens up great opportunities to significantly improve the quality of mathematics learning, especially through the use of innovative interactive learning media, such as specially designed educational games. Educational games offer promising innovations by creating a much more engaging learning environment and motivating students to be actively involved in the learning process.

Through a fun and interactive learning-by-play approach, math concepts that were previously considered difficult and challenging can be delivered in a way that is more entertaining, easy to understand, and relevant to everyday life, thus potentially changing students' negative perceptions of mathematics and overall significantly increasing the effectiveness of learning (Candra & Rahayu, 2021; Hamid & Afriansyah, 2024). Maharani et al. (2024) showed that the use of educational games was proven to improve math scores and student motivation at the elementary school level.

Previous studies have successfully established a varied and rich ecosystem of math education games by adopting various software development models, including Game Development Life Cycle (GDLC), Waterfall, and desktop application-based implementation (Rachman et al., 2019).

This approach is also in line with the principles of the ADDIE model which is widely used in learning media development (Hani et al., 2020). The findings from this study showed positive results, indicating the significant potential of educational games in increasing students' learning motivation and improving overall math learning outcomes (Devinra et.al., 2024).

Putri and Airlanda's (2020) research also shows that fraction educational games can significantly improve student learning outcomes. However, there are still some important gaps that need attention. One of them is the product validation process, which in many previous studies has not been carried out thoroughly, so that the level of feasibility and effectiveness of games as learning media has not been fully tested scientifically (Supriadi et al. 2020).

The integration of learning materials into the core game mechanics is another crucial aspect that needs to be considered; often the learning materials feel less integrated and separated from the actual game flow, potentially reducing students' interest and attraction to actively engage in the learning process. Platform limitations, especially desktop applications, are

also a barrier that limits the accessibility of learning media, thus inhibiting students from learning outside the formal school environment or in conditions without the availability of adequate computer devices.

In addition, the number of educational games specifically designed to accommodate the needs of 5th grade elementary school students in learning simple fractions is still very limited. Therefore, the effectiveness of educational games in this more specific context requires significant improvements in design, customization of relevant and contextualized content, as well as ongoing follow-up research to ensure a sustained positive impact on the understanding of simple fraction concepts in 5th grade students.

The novelty of this research lies in the development of innovative game-based learning media designed using the Unity platform, and designed to be accessed multi-platform, both through websites and Android devices (Srisulistiowati et al., 2021).

The choice of multi-platform approach is based on the desire to provide maximum flexibility to learners in accessing learning materials, while expanding the distribution range of learning media. The main focus of this research lies in the design of an interactive and immersive learning experience that aims to stimulate and increase learners' interest in learning, especially in understanding the basic concepts of simple fractions.

To ensure the quality and relevance of the learning media produced, a comprehensive validation process will be implemented, involving experts who are competent in the field of Mathematics subject and Learning media design. This validation is considered important to ensure that the learning media developed has met the necessary pedagogical and technical standards, so that it can effectively support an optimal teaching and learning process and contribute significantly to the overall improvement of learners' learning outcomes.

This comprehensive validation process will evaluate various crucial aspects, including the accuracy of the material presented, the level of ease of understanding of the material by students of various ability levels, the relevance of learning media to the current curriculum, and the effectiveness of media design in attracting students' attention and facilitating understanding of the concept of simple fractions taught, thus ensuring that learning is effective and in accordance with student needs (Mas U'd & Huda, 2024).

This is reinforced by the findings of Norviansyah et al. (2024) who emphasized the importance of mapping student needs before developing mathematics game media. The development of Runner Mathematics learning media is expected to be an innovation that is relevant to the needs of students in the digital era, effectively increasing interest in learning and deepening understanding of mathematical concepts, especially simple fraction material. Thus, Runner Mathematics is expected to have a positive impact on mathematics learning in elementary schools, resulting in a more competent generation in the field of mathematics.

## 2. METHOD

This study used the Research and Development (R&D) approach as the main methodology. The research was conducted in the first 2 weeks of June 2025 at SDN 11 Ciracas, aiming to develop and validate an innovative product that is expected to contribute significantly to improving the quality of education and the effectiveness of learning. In carrying out this R&D approach, the research adopted the ADDIE model (Analyze, Design, Development, Implementation, Evaluation), a systematic and step-by-step framework that has been widely recognized.

The selection of the ADDIE model is based on the belief that this model provides a strong and directed foundation for a comprehensive product development process. Through the ADDIE model, researchers can comprehensively analyze, design, develop, implement, and evaluate every aspect of the product through a series of clearly defined stages (Waruwu, 2024). This structured structure not only facilitates measurable phased implementation, but also ensures that each element of the product is carefully evaluated and refined based on empirical data and feedback obtained during the research process.

A visual breakdown of the stage design in the ADDIE model implemented specifically in this study can be observed in Figure 1, which presents a clear graphical representation of the research workflow as well as the main focus emphasized at each stage of product development, thus providing a deep understanding of the overall research process.

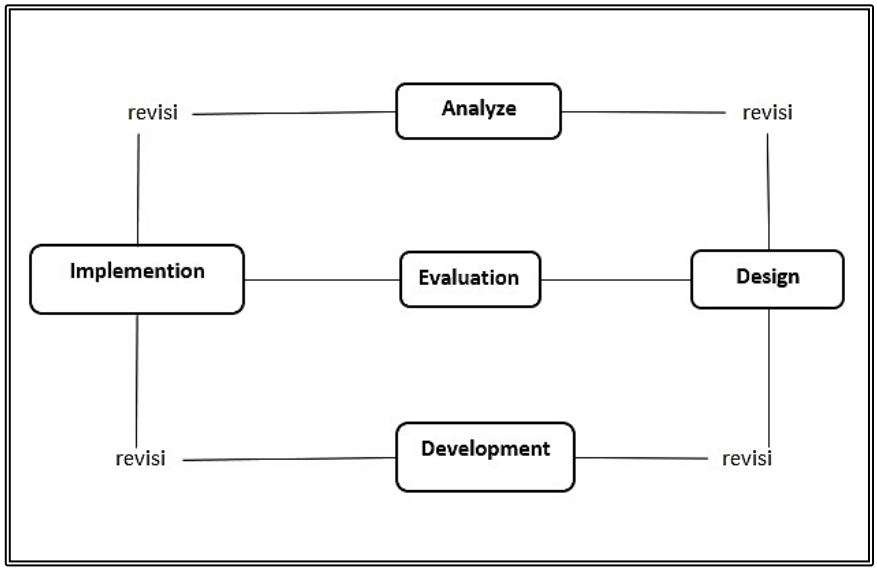


Figure 1. Design Stages of ADDIE Development Model

In the realm of learning design, diversity of approaches is key to creating effective and relevant learning experiences. The various learning design models that exist today reflect the complexity of modern educational needs. These models range from structured procedural models, such as the ADDIE model (analysis, design, development, implementation, evaluation),

which offers a systematic framework with clear and sequential stages for learning development. ADDIE provides step-by-step guidance, ensuring each phase of development is carefully observed and measured.

On the other hand, there are non-procedural models that are more adaptive and flexible, for example the Agile Learning Design model, which offers flexibility in the design process, allowing for rapid iteration, adaptation based on feedback, or initiation of phases most relevant to specific learning needs (Mas U'd & Huda, 2024). Agile models emphasize responsiveness to change and feedback, allowing for continuous improvement throughout the development process.

Alternatively, the Integrated Learning Design model seeks to integrate measurable learning objectives, relevant and engaging learning materials, effective teaching methods and comprehensive evaluation holistically into a coherent whole, which ensures harmony between each element to achieve optimal learning outcomes. This integrated approach focuses on coherence and synergy between all learning components to maximize positive impact on learners.

The research is organized into three main stages that are closely interrelated, ensuring a systematic and purposeful flow of research, from data collection and needs analysis, to design and development of learning interventions, to evaluation of the effectiveness and impact of the interventions. This three-stage structure ensures that the research is conducted comprehensively, from a deep understanding of the needs to a careful assessment of the results achieved.

The initial stage of product development involves validation testing, an important phase that involves in-depth evaluation by experts in the relevant field. At this stage, the well-designed product is comprehensively assessed from a variety of perspectives, including its functionality to ensure it performs according to the stated objectives, its design quality to ensure it is attractive and supports a positive user experience, its reusability to ensure it can be accessed and utilized by a wide range of people without significant difficulty, and its potential for the learning process, including its effectiveness in delivering material and facilitating understanding.

These experts provide valuable constructive feedback, identify product strengths that need to be maintained and improved, as well as weaknesses that need to be corrected and provide specific and measurable improvement recommendations, including clear implementation suggestions. The main purpose of this validation test is to ensure the readiness of the product before it is widely implemented in the actual learning environment, thus minimizing the risk of failure and maximizing the positive impact.

Based on the feedback obtained during the rigorous validation process, the product will undergo a series of revisions and refinements repeatedly (iterative process), with the main focus

on improving its quality, effectiveness in achieving learning objectives, and relevance to the diverse needs of users who may have different backgrounds and learning styles. This iterative process ensures that the resulting product is truly optimized, adaptive and ready to make a significant positive contribution in improving the overall quality and efficiency of the learning environment.

The second stage of product development focused on the field trial conducted at SDN 11 Ciracas, a crucial stage aimed at collecting valid and reliable empirical data regarding the effectiveness of the product in the context of actual use in a school setting. The design of this trial involved the active participation of students who were divided into three groups of different sizes, with the aim of maximizing the acquisition of data from a variety of perspectives that might emerge.

Two small groups, each consisting of five students, were formed specifically to conduct in-depth observations of individual interactions between students and the product. This approach was designed to generate a rich and detailed qualitative understanding of the user experience, allowing the researchers to identify nuances and subtle details in the use of the product that might be missed if conducted on a larger scale. Meanwhile, a larger group, consisting of 30 students, was formed with the primary objective of collecting more statistically representative quantitative data. This quantitative data is expected to reflect the overall performance of the product on a broader scale, provide a comprehensive picture of the product's acceptance in the classroom environment, and objectively measure the impact of the product based on established metrics.

Data collection techniques in this study included observation, unstructured interviews, and distributing questionnaires to students and expert validation. Observation was used to see students' direct interaction with the product during the trial. Questionnaires were used to obtain student responses and assessments of the product, while expert validation was carried out through feasibility assessment instruments by material experts and media experts.

At the conclusion of the pilot, all students involved were asked to complete a comprehensive questionnaire. This questionnaire is designed to gauge student responses to key aspects of the product, including its practical usefulness in supporting teaching and learning, the level of usability perceived by students, and the overall impact of the product on the effectiveness of teaching and learning in the classroom, ultimately providing an overall evaluation of the learning objectives set.

The product assessment phase plays a central role in the product development process, with an emphasis on structured data collection through a series of statements or questions specifically designed to accurately capture respondents' views. During this phase, each respondent is given the opportunity to subjectively express their personal opinions and

experiences regarding the product being evaluated. The data collected, generally through questionnaire instruments, is then analyzed quantitatively using a Likert scale. The data analysis technique is quantitatively descriptive. Data from student response questionnaires and expert validation were analyzed using the calculation of the average score, then categorized into feasibility assessment criteria based on certain value intervals to determine the quality and attractiveness of the developed media.

The Likert scale, as a widely used psychometric scaling method, plays an important role in measuring various psychological aspects, including a person's attitudes, opinions, and perceptions towards a certain object or issue. The validation of a product is determined based on the fulfillment of the "feasible" criteria, which is exclusively based on the results of data analysis obtained through the Likert scale.

The overall product validation assessment is then summarized and presented in tabular form, which summarizes the average total score of all respondents, thus providing a comprehensive and representative picture of the level of acceptance and feasibility of the product in the eyes of potential users (Hani et al., 2024).

Table 1. Expert Validation Scoring

| Achievement level | Description |
|---|---|
| $4.00 < x \leq 5.00$ | Very decent |
| $3.00 < x \leq 4.00$ | Decent |
| $2.00 < x < 3.00$ | Quite decent |
| $1.00 < x < 2.00$ | Less decent |
| $x < 1.00$ | Very not decent |

After validation and improvement based on feedback and evaluation, this application is ready to be tested on students to measure its attractiveness as a game-based learning media. The purpose of this trial is to see how effective this app is in attracting students' interest in learning. The app is considered "interesting" if it meets the predetermined criteria, as listed in Table 2 which details the criteria for the attractiveness of Unity apps as math learning media.

Table 2. Student Feedback Scoring

| Achievement level | Description |
|---|---|
| 5 | Very Suitable |
| 4 | Suitable |
| 3 | Quite suitable |
| 2 | Less suitable |
| 1 | Very unsuitable |

Table 3. Percentage of Student Responses

| Achievement level | Description |
|---|---|
| $75\% < \bar{Y} \leq 100\%$ | Very interesting |

| Achievement level | Description |
|---|---|
| 60% < $\bar{Y}$ ≤ 75% | Interesting |
| 45% < $\bar{Y}$ ≤ 60% | Quite interesting |
| 20% < $\bar{Y}$ ≤ 45% | Less interesting |
| 0% < $\bar{Y}$ ≤ 20% | Very not interesting |

## 3. RESULT AND DISCUSSION

The development of this learning media resulted in a Unity-based application specifically designed to facilitate the understanding of fraction concepts. This application is not just a final product, but has gone through a series of rigorous and comprehensive validation stages. The validation process involves active participation from various experts in related fields, including learning material experts who are tasked with ensuring the accuracy, depth, and suitability of the content with the applicable curriculum.

Media experts were also engaged to review the visual aspects, attractiveness and interactivity of the app, ensuring an engaging and motivating learning experience. The technical aspects of the app were evaluated by technology experts focusing on functionality, stability and ease of use. Teachers as field practitioners provided valuable feedback based on their teaching experience and direct interaction with students, to ensure the app is relevant to classroom needs.

Validation The data collected from the experts was carefully analyzed using a five-point scale to quantitatively measure and determine the level of validity of the learning media, thus providing an objective picture of the app's feasibility. The app development process itself followed a systematic methodology, starting with a needs analysis of the students to identify their specific learning challenges, followed by designing an intuitive and easy-to-navigate interface (UI) and learning flow, thus minimizing user confusion.

The next stage is the development and implementation of the application using the Unity platform, which was chosen for its ability to integrate multimedia elements and rich interactivity, thus creating an immersive learning environment. Finally, continuous evaluation and revision is carried out based on feedback obtained from experts and users, to ensure the app is continuously improved, relevant to curriculum developments and responsive to changing learning needs.

The overall validation results consistently show that this application meets high standards of feasibility and can be relied upon as an effective learning media for fraction materials, offering innovative solutions to improve student understanding The analysis stage in the development of this Unity-based learning media includes identification of needs, student characteristics, learning and relevant sources.

This stage is very important because it aims to deeply understand students' needs and formulate measurable learning objectives. A comprehensive analysis at this stage will provide a

solid foundation for creating learning media that is effective and relevant to the target users. The following is a detailed explanation of the steps taken in this stage:

1) Initial analysis. Researchers collected initial information and evidence related to the obstacles experienced by students in understanding fraction material.
2) Identifying learning objectives. Researchers set learning objectives, namely students are expected to understand the concept of fraction material better using unity-based media.
3) Analyze user needs. Researchers conducted observations and interviews with teachers and students to identify the skills and knowledge needed and understand the obstacles faced.
4) Technology analysis. We chose Unity application as the development platform because of its flexibility in creating interactive content and its ability to run on various platforms. Researchers also ensured the compatibility of the Unity application used with the hardware that will be used by students, such as Android smartphones or tablets.

The design stage in learning media development is an in-depth and detailed planning stage. At this stage, the learning media designer focuses on how the media will operate and provide an optimal learning experience. Some important aspects that become the main concern in the design stage include.

The application usage scenario is compiled comprehensively. This scenario covers the stages of using the application, starting from the initial introduction to the entire usage process. The purpose of the learning flow design is to ensure users (students) can easily understand how to use the learning media and get the maximum benefit from the features available.

1) Unity elements must be carefully planned. Choosing the right elements will help create a more engaging and effective learning experience. This interaction design considers how users interact with the visual and functional elements in the learning media, with the aim of improving comprehension and retention of the material.
2) Interactive features are added to enhance learning effectiveness. For example, material buttons are equipped with interactive features to help students understand concepts, as well as games designed to measure students' understanding of the material. These features aim to make the learning process more fun and interactive, so that students are motivated to learn and understand the material better.


Figure 2. Media Start View

The initial appearance of this application was designed with simplicity and ease of use in mind. As an illustration, when the app is opened (as shown in Figure 2), students are immediately presented with the option to click the "play" or "learn" button to proceed to the next stage. Furthermore, users will be directed to scan the website link that has been shared through the students' WhatsApp group. This process aims to ensure that the designed learning media can be easily accessed by students, while fulfilling the need for interactive learning.

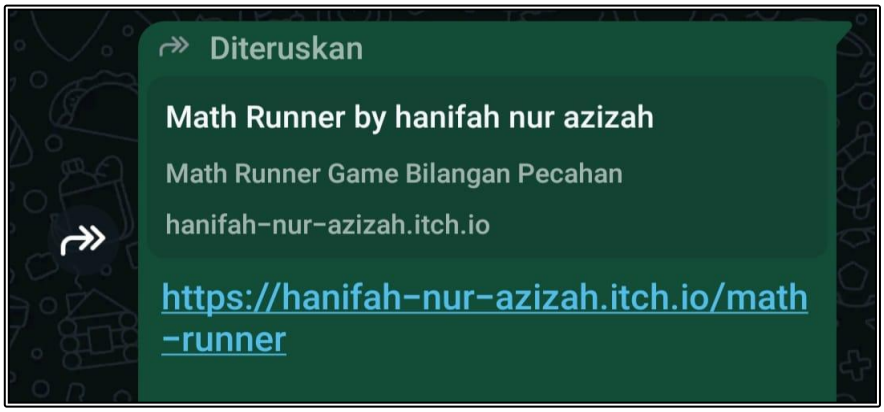


Figure 3. Link URL to Display Learning Media Applications Runner Mathematics


Figure 4. Math Runner App Display When Viewing Using URL Link

The Development stage is carried out based on the design that has been previously designed. Some of the main steps in this stage include:

1) Android application development. The application is designed and developed using appropriate programming software to ensure optimal functionality.
2) Implementation of Math Runner. This feature is implemented to display fractions in three-dimensional form. These objects can be rotated and explored by students to provide a more interactive learning experience.
3) Validation by material experts, media experts and technology experts. This assessment aims to evaluate the feasibility of the developed product. The product is considered valid and feasible to use if it meets the minimum criteria of the "feasible" category.

The validation process is an important stage in the development of learning media. The needs analysis by Saputri (2023) emphasized the importance of understanding the characteristics of students and infrastructure before the development of mathematics educational game media. The assessment by these experts is the basis for product improvement and refinement, so that the learning media produced can be used effectively by students (Devinra et.al., 2024). The results of the assessment conducted by the three experts can be seen in Table 4 which contains details of the aspects evaluated.

Table 4. Validator Validation Results

| Validator | Suggestion | Revision 1 | Revision 2 |
|---|---|---|---|
| The Material | Students are sought to be given conceptual understanding, not procedural, for example "why when working with fractions whose denominators are different must be equated with equivalent fractions (this needs to be given illustrations or concrete media) | Suitable for use | |
| Media Notes | There is no suggestion | Suitable to use without revision | |
| Technology | From detailed material technology and inertial devices, interactive play ways | Need revision before use | Worth using without revision |

The development of this learning media resulted in a Unity-based application specifically designed to facilitate the understanding of fraction concepts. This application is not just a final product, but has gone through a series of rigorous and comprehensive validations to ensure its quality and effectiveness as a learning tool in Bantul. The validation process involved various experts from various related disciplines, including learning material experts who were

responsible for ensuring the accuracy, depth and alignment of the content with the current curriculum. In addition, media experts were also involved to assess and provide feedback on the visual aspects, attractiveness and interactivity of the application, with the aim of creating an optimal and attractive appearance and user experience.

The technical aspects of the app, including functionality, stability and compatibility with various devices, were carefully evaluated by information technology experts. The role of teachers as field practitioners is also crucial, where they provide feedback based on their direct experience in teaching and interacting with students, ensuring the app is truly relevant to classroom learning needs. The data collected from the experts was then analyzed in depth using a five-point scale, a quantitative method that allows to measure and determine the level of validity of the learning media in a more objective way.

The app development process itself follows a systematic and structured methodology, starting with a learner needs analysis to identify the most common learning challenges faced. This needs analysis forms the basis for designing an intuitive and easy-to-navigate interface (UI) design, as well as a logical and effective learning flow. The next stage is the development and implementation of the application using the Unity platform, which was chosen for its ability to integrate rich multimedia elements, such as animations, videos and interactive simulations, to enrich learners' learning experience.

The continuous evaluation and revision process is carried out iteratively based on the feedback obtained from experts and users, so that the app is continuously improved and remains relevant to the dynamics of evolving learning needs. Overall, the validation results obtained show that this application meets high feasibility standards and can be relied upon as an effective, innovative, and relevant learning media for fraction materials.

Before the field trial of Runner Mathematics, a student response questionnaire was given to measure the extent to which they often use learning media. The distribution of student response questionnaires obtained 45.27.27% which indicates that they rarely use learning media while studying.

The field trial of Runner Mathematics was designed to closely observe the dynamics of interaction between students and teachers in the context of mathematics learning. In its implementation, students were organized into two main groups, namely large groups and small groups.

Subsequently, the small group was further divided into two smaller sub-groups, each consisting of five students. This strategic group division structure aims to optimize the effectiveness of monitoring and mentoring individuals during the app usage process.

Through this pilot, students had the valuable opportunity to collaborate in solving math problems, conduct in-depth exploration of the various features and functions available in the app,

and deepen their understanding of curriculum-relevant math materials. This learning process was supported by the advanced technology provided by the Unity-based app, which is designed to create an immersive and interactive learning experience.

Observation results obtained during the pilot test showed that this digital learning media had a significant positive impact on increasing students' overall learning motivation. The data showed that about 83.5% of the students expressed high enthusiasm towards the use of Runner Mathematics, while the other 70% felt that their understanding of the material taught became easier and more comprehensive thanks to the integration of this application into the teaching and learning process in the classroom (Awaliyah & Yani, 2025). This is in line with the meta-analysis conducted by Fadda et al. (2021), who found that the use of digital games in math learning significantly increased student motivation and engagement compared to conventional methods.

Figure 5. Assist Students in the Use of Unity Applications

The Evaluation stage is carried out to see the effectiveness of the learning media and obtain feedback for further improvement. some of the steps taken in this stage include:

1) Evaluate the learning process to measure the extent to which the unity application helps students understand fraction material.
2) Collect feedback from students and teachers regarding ease of use, comfort, understanding of fraction material in increasing learning motivation.
3) Analyzing learning outcomes by evaluating the improvement of students' concept understanding after using unity-based learning media.

The results of the student response questionnaire showed that of the 10 questions, 83.5% received a response in the interested category (Febriyanti & Rachmawati, 2022). This is in line with previous research by Rachman & Mahardika (2020) and Istiq'faroh et al. (2024) through a literature review found that the use of interactive platforms such as Wordwall and Quizizz significantly increased student interest and engagement. Figure 6 shows the activity of filling out the response questionnaire before the activity ends.

Based on the feedback and evaluation results, the application can be improved or updated to enhance the user experience. Learning media is said to be interesting if it meets the criteria of "interesting" with high evaluation results (Devinra et.al., 2024).

Figure 6. Students Fill Out Student Responses to Unity-based Learning Media

Modern learning media offer a number of significant advantages that change the way educational materials are delivered and received. Compatibility across different versions of the Android operating system ensures that apps and learning materials can run smoothly on various devices without technical issues, so users with different Android devices can access the same content.

The ability to adapt to various screen display resolutions provides an optimal visual experience across a wide range of devices, from smart phones to tablets, ensuring that text, images and other visual elements are displayed clearly and proportionately. Accessibility without geographical and time limits allows learners to access learning materials anytime and anywhere, freeing them from the time and space constraints that are often a barrier in traditional learning. This flexibility, as supported by the research of Fadilah et al. (2023) who utilized URL links for Material Distribution, presents an effective and efficient digital-based material delivery model.

The potential of Android-based learning media as a rich and easily accessible learning resource is expected to increase students' learning motivation (Supriadi et al., 2020). Furthermore, it encourages teachers' innovation and self-development in utilizing relevant and interesting learning media, thus contributing to a comfortable, active, and fun classroom environment, in line with Sutmo et al.'s research. (2023) on the educational game "Math Runner" designed for interactive math learning for elementary school students.

In the Math Runner game, players are not only tested for their motor skills in running and avoiding obstacles, but also their mathematical intelligence. Players are challenged to collect as many coins as possible while answering various math problems covering basic operations such as addition, subtraction, multiplication and division. The speed and accuracy in solving these math problems directly affects the final score. The development of Math Runner follows The Game

Development Life Cycle (GDLC) model with six phases: initialization (concept creation), preproduction (detailed planning), production (asset implementation and program development), testing (alpha and beta), and release (launch to the public) (Awaliyah & Yani, 2025).

This educational game is designed as an innovative solution to increase students' interest in math. The combination of interesting game elements with relevant math material has the potential to make Math Runner an effective learning tool (Lozano et al., 2023). Research shows that educational games such as Math Runner have great potential as a fun, interactive, and personalized alternative learning medium for students, thus potentially improving students' understanding of mathematical concepts and overall academic performance. This finding is reinforced by the study of Apriyantini et al. (2024), who developed an educational game based on realistic mathematics and showed that this approach was effective in improving the understanding of mathematical concepts of 5th grade students.

The trial proved the feasibility of implementing the game in primary school mathematics learning, making it a valuable tool for teachers and students in teaching and learning activities, and offering a new and more interesting approach to learning mathematics (Sutmo et al., 2023).

## 4. CONCLUSION

Based on the in-depth analysis of the Android-based mobile learning development, several main conclusions can be drawn. First, the development of Android-based Interactive Learning media was successfully realized through the systematic application of the ADDIE model. This model consists of five crucial phases: analysis, which focuses on identifying learners' needs and characteristics; design, which includes drafting content architecture and intuitive user interface design; development, which is the process of producing learning media concretely; implementation, which involves applying the media in an actual learning context; and Evaluation, which aims to measure the overall effectiveness and efficiency of the learning media.

Second, the Android-based mobile learning media produced has gone through a rigorous validation process by a team of experts who are competent in their fields. The team consists of learning material experts who ensure the accuracy and relevance of the content, learning media experts who assess the visual quality and interactivity, and learning technology experts who comprehensively evaluate the technical aspects and functionality of the application. Furthermore, this media was also empirically tested on 5th grade students of SDN Ciracas 11 morning to gather direct feedback from the target users.

The validation results from the experts consistently show that this learning media is very feasible and meets high quality standards to be applied in a formal learning environment. Thirdly, the data obtained from the implementation trial in the field significantly showed that this mobile

learning media had a positive impact on students' learning motivation. Quantitatively, it was revealed that 75% of students showed increased enthusiasm in learning when using this media, indicating an increased engagement and interest in the learning materials. In addition, 70% of students reported that they found it easier to understand the material presented through the mobile learning application, demonstrating the potential of this media in facilitating better understanding of concepts and improving the efficiency of the learning process.

In addition to these findings, this research makes a significant contribution to the development of digital learning media that integrates interactive approaches with mobile technology, which can be used as a reference for other developers in creating similar media at the basic education level. This research also provides a real picture of the application of the ADDIE model in the context of developing educational games for learning mathematics.

As a suggestion, further research could develop features that are more adaptive to students' individual needs, as well as expand the material coverage to other mathematics topics. In addition, the pilot test should be extended to more schools with a variety of student backgrounds to obtain more generalized results.

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## AUTHOR BIOGRAPHY

**Hanifah Nur Azizah**

Born in Jakarta, on 8 June 2002. Completed undergraduate studies in Primary School Teacher Education at Universitas Muhammadiyah Prof. Dr. HAMKA, Jakarta, in 2025. Her academic interests include the development of educational media, elementary school pedagogy, and the integration of technology in learning.

**Drs. Kusmajid Abdullah, M.Pd.**

Born in Madiun, on 2 December 1968. Faculty member at the Primary School Teacher Education Program, Faculty of Teacher Training and Education, Universitas Muhammadiyah Prof. Dr. HAMKA. Completed undergraduate and graduate studies in Education. Holds the position of permanent lecturer with the academic rank of Lector.