Development of android-based educational game media math adventure using powerpoint add-ins ispring and apk builder

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Abstract
The problem in mathematics learning, particularly on the topic of function composition, often causes students to struggle. Monotonous teaching methods and the limited use of instructional media lead students to feel bored and lose interest in learning. This study aims to develop an instructional media in the form of an Android-based educational game called GEMA (Game Edukasi Math Adventure), which utilizes PowerPoint add-ins iSpring and APK Builder. Through this research, it is expected that the GEMA learning media can enhance students' understanding of the concept of function composition in an interactive and engaging way. The method used in this research is development research with the ADDIE model, and data analysis techniques include validity, practicality, and student responses. The results of the study show that the Android-based GEMA instructional media obtained validation with an average total percentage of 90%, which falls into the excellent category. In terms of practicality, this media received an average total percentage of 80.5%, which is categorized as practical. The students' response to this instructional media reached an average total percentage of 81.5%. These findings indicate that the Android-based GEMA instructional media is not only valid and practical but also received a positive response from students. Therefore, the GEMA instructional media is suitable for use in mathematics learning on the topic of function composition.
Keywords: Android; Educational Games; Learning Media

Abstrak
Permasalahan dalam pembelajaran matematika, khususnya pada materi fungsi komposisi, sering kali membuat peserta didik mengalami kesulitan. Metode pengajaran yang monoton dan penggunaan media pembelajaran yang terbatas menyebabkan peserta didik merasa bosan dan kehilangan minat belajar. Penelitian ini bertujuan untuk mengembangkan media pembelajaran berupa *game* edukasi berbasis *android*, bernama GEMA (*Game* Edukasi *Math Adventure*), yang menggunakan *PowerPoint add-ins iSpring* dan *APK Builder*. Melalui penelitian ini, diharapkan media pembelajaran GEMA dapat meningkatkan pemahaman peserta didik terhadap konsep fungsi komposisi dengan cara yang interaktif dan menarik. Metode yang digunakan dalam penelitian ini adalah penelitian pengembangan dengan model pengembangan ADDIE dan teknik analisis data meliputi kevalidan, kepraktisan, dan respon peserta didik. Hasil penelitian menunjukkan bahwa

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media pembelajaran GEMA berbasis android memperoleh validasi dengan rata-rata total persentase 90%, yang termasuk dalam kategori sangat baik. Dari segi praktikalitas, media ini memperoleh rata-rata total persentase 80,5%, yang termasuk dalam kategori praktis. Respon peserta didik terhadap media pembelajaran ini mencapai rata-rata total persentase 81,5%. Temuan ini mengindikasikan bahwa media pembelajaran GEMA berbasis android tidak hanya valid dan praktis, tetapi juga mendapat respon positif dari peserta didik. Dengan demikian, media pembelajaran GEMA layak digunakan dalam pembelajaran matematika pada materi fungsi komposisi.
Kata Kunci: Android; Game Edukasi; Media Pembelajaran

Introduction

With the rapid advancement of technology, mathematics education in schools is now faced with various new opportunities and challenges. Educational technology has evolved significantly, offering a wide range of tools and media to enrich the learning process (Latifah, 2024). However, many schools especially those in rural areas have yet to utilize this technology optimally. The use of conventional media such as Student Worksheets and textbooks still dominates (Sujarwo, 2021; Basir, Agustyani, & Maharani, 2024). Although these media have long played an important role in the learning process, their limitations are becoming increasingly apparent, especially when addressing the needs of the digital generation who are more familiar with technology.

Conventional media tend to be static and lack interactivity, thus failing to fully capture students' attention and interest. Alatas (2019) stated that the use of conventional media often causes boredom and can even result in low learning motivation. This is supported by Jannah (2019), who found that textbooks and worksheets often lead to difficulties in understanding the material, particularly in subjects that require comprehension of abstract concepts, such as mathematics.

Specifically in high school mathematics, the topic of function composition is a crucial yet challenging subject (Ratna & Yahya, 2022). It requires an understanding of relationships between functions and the ability to construct new functions from two or more existing ones. Although it is introduced at the junior high school level, many students still struggle to grasp it thoroughly. Interviews conducted by Tantri and Fahmi (2020) revealed that students experienced confusion when learning about function composition and inverse functions due to the abstract nature of the concepts and the often complex diagrams. Similarly, Susanti and Lestari (2019) found that students faced difficulties in solving problems related to function composition, both in terms of conceptual understanding and problem-solving skills.

This situation highlights the urgent need for learning media that can deliver mathematical content in a more engaging, interactive, and accessible manner. Technology emerges as a potential solution. According to Wangge (2020), technology-based

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instructional media can enhance the quality of learning, broaden access, and simplify the understanding of abstract material. Yuliza (2023) also noted that technology-based media make students more active, creative, and enthusiastic in the learning process. One of the technologies most integrated into students' daily lives is the smartphone. In addition to being easily accessible and user-friendly, smartphones have great potential to serve as flexible and engaging learning media. Smartphones can be a representative medium for learning and allow students to revisit the material anytime and anywhere (Simin, 2021). According to data from Simon, approximately 59% of smartphone use is dedicated to playing games (Wulandari, 2021). Observations by Febian (2021) also showed that students tend to be more interested in learning mathematics when it is presented in game form, as they find games more engaging, exciting, and frequently accessed.

These facts indicate the urgency of developing Android-based educational game media. Educational games not only offer a fun and interactive approach but also provide a more comprehensible way of delivering complex material such as mathematics (Meilina, Mariana, & Rahmawati, 2023). Moreover, recent trends show that smartphone-based educational games have great potential to improve time efficiency and provide an engaging learning experience (Moscato, 2023). Considering these challenges and opportunities, developing interactive learning media in the form of an Android-based educational game for the topic of function composition is both important and relevant. This media is expected to serve as an innovative solution to deliver mathematical content effectively and engagingly, while addressing the limitations of conventional media that still dominate many schools.

Therefore, this study aims to develop and evaluate "Game Edukasi Math Adventure" (GEMA), an Android-based learning media created using PowerPoint with iSpring add-ins and APK Builder. This research focuses on the development process, validity, practicality, and student responses to the media. Through this study, it is expected that an innovative solution will be found to improve the quality of mathematics learning and overcome the limitations of existing conventional media.

Method

This study employed a research and development (R&D) method using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. In the analysis stage, needs assessment and curriculum analysis were conducted through interviews with mathematics teachers. The design stage involved the creation of a flowchart and storyboard, as well as the collection of learning materials. The development of the media was carried out based on the prepared storyboard, followed by validation from subject matter experts and media experts, along with revisions based on

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the feedback received. The implementation stage included a limited trial and a field trial involving students to assess the practicality of the media and user responses. Evaluation was conducted formatively to reflect upon and revise the product based on the results of the trials and validations.

This research was conducted at a state Islamic senior high school in Sukabumi Regency during the second semester of the 2023/2024 academic year. The data collected included qualitative data in the form of feedback and suggestions obtained from validation and practicality sheets, as well as quantitative data in the form of validation scores and student responses. The research instruments included validation sheets, practicality sheets, and student response questionnaires. Data were processed using Microsoft Excel 2013. The questionnaires consisted of closed-ended questions using a rating scale with five answer choices for each statement based on a Likert scale, and open-ended questions used to gather feedback and suggestions in the validation and practicality sheets. The data obtained from the validation of the subject matter and media users were then processed using the following formula:

$$\text{Validity Score} = \frac{\text{Score obtained for the item}}{\text{Maximum score}} \times 100\%$$

After the percentage results from the validation questionnaire calculation are obtained, they are then interpreted according to Table 1.

Table 1. Expert Validation Rating Categories

Interval	Description
$81\% - 100\%$	Very good
$61\% - 80\%$	Good
$41\% - 60\%$	Moderate
$21\% - 40\%$	Poor
$0 - 20\%$	Very poor

(Sofnidar & Yuliana, 2018)

Learning media is considered valid and usable if the validity percentage reaches a minimum score of 41% (Nurhayati et al., 2023). Data from the practicality results are processed using the following formula:

$$Practicality\ Score = \frac{Score\ obtained\ for\ the\ item}{Maximum\ score} \times 100\%$$

The practicality categories are classified according to Table 2:

Table 2. Practicality Categories

Interval	Description
$85\% - 100\%$	Very practical
$75\% - 84\%$	Practical
$65\% - 74\%$	Quite practical
$55\% - 64\%$	Less practical
$0 - 54\%$	Not practical

(Komariyah, 2016)

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Learning media is considered practical if the average percentage of the practicality sheet falls into the categories of very practical, practical, or quite practical (Sari and Siswono, 2020). The student response data is processed using the following formula:

$$\text{Percentage} = \frac{\sum Score}{\text{Maximum score}} \times 100\%$$

The criteria for evaluating the student response results are as follows:

Table 3. Student Response Criteria

Interval	Description
$81\% - 100\%$	Very good response
$61\% - 80\%$	Good response
$41\% - 60\%$	Satisfactory response
$21\% - 40\%$	Poor response
$0 - 20\%$	Very poor response

(Riduwan, 2012)

Result

The development process of the GEMA (Game Edukasi Math Adventure) Android-based learning media was carried out using the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation.

The first stage, Analysis, includes both a needs analysis and a curriculum analysis. The needs analysis was conducted through an interview with a mathematics teacher at a senior high school in Sukabumi to identify challenges encountered in the learning process. The results indicated that students still faced difficulties in understanding the topic of function composition. Furthermore, the use of technology in learning was not yet optimal, with learning resources still being teacher-centered. This condition made students less independent in their learning, as they tended to wait for teacher explanations rather than actively seeking information and understanding the material on their own. The use of smartphones as learning tools had also not been fully utilized, even though most students owned smartphones that could serve as effective learning media. Therefore, effective instructional media are necessary to address these problems one of which is the development of GEMA.

GEMA is designed to present the concept of function composition in an engaging and interactive format. This media can be accessed anytime and anywhere via students' smartphones and includes game-based elements to boost motivation and student engagement. As Guritno and Huda (2023) stated, adventure genre educational games can serve as effective learning tools because they help students grasp complex mathematical concepts in a fun and interactive way. Thus, GEMA is expected to help students overcome

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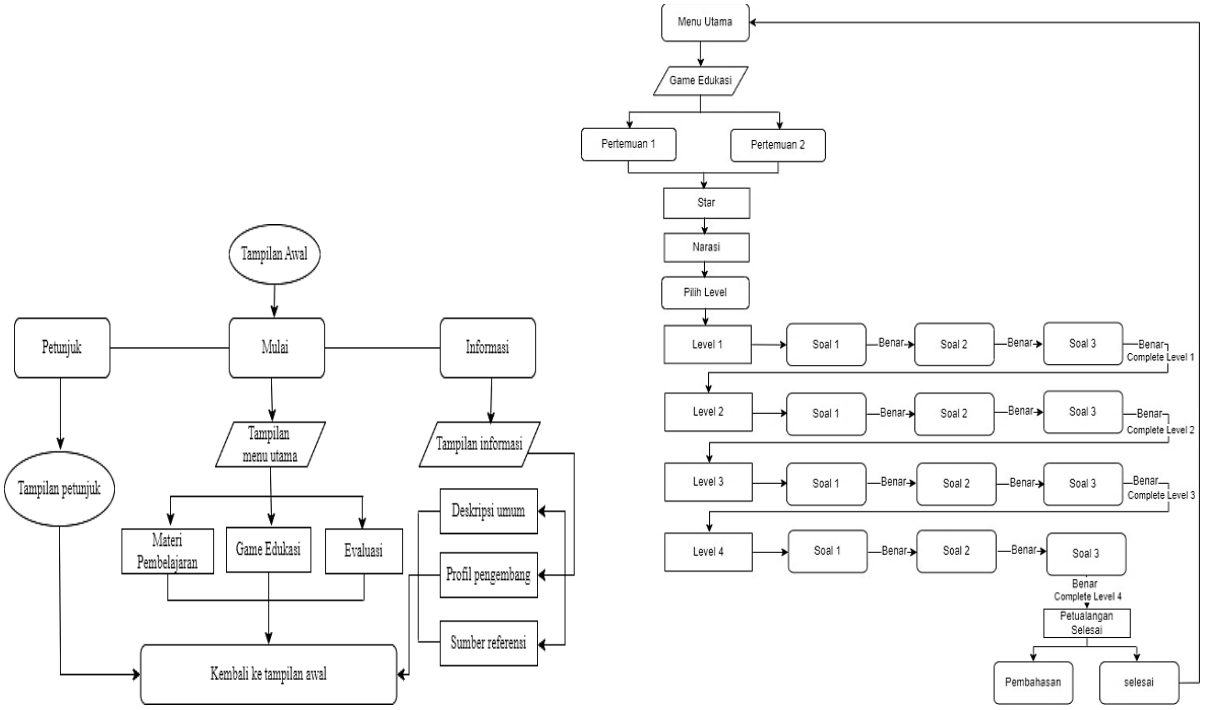
learning difficulties, improve the integration of technology in education, reduce dependence on teachers, and optimize smartphone usage as a learning aid.

The curriculum analysis was conducted to ensure that the learning media aligns with the curriculum used by the school. It was found that the high school in Sukabumi implements the Merdeka Curriculum, particularly for 10th grade. Therefore, the GEMA learning media was developed based on this curriculum. One of the topics planned for the second semester of 10th grade is function composition. However, according to the Merdeka Curriculum guidelines, this material is ideally taught at the end of Phase F, which is the final stage of the high school mathematics curriculum. Faced with this situation, the researcher made adjustments based on the actual conditions of the school. This included integrating the function composition topic into the 10th-grade curriculum to better suit the students' needs and context, thereby ensuring that learning objectives could be achieved more effectively.

The second stage in the development of the GEMA instructional media is the design stage, which focuses on planning the flow and interface of the media. During this stage, a flowchart and storyboard are created as references for the media development process. First, a flowchart is prepared to illustrate the overall system workflow. This flowchart serves to clarify the process flow within the Android-based GEMA instructional media, thus facilitating the developer in systematically and efficiently realizing the media's working structure.



(a) (b)

Figure 1. Flowchart of GEMA Instructional Media

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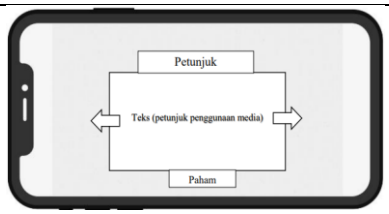
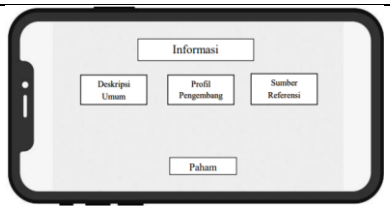
After the flowchart is completed, the next step is to develop the storyboard. The purpose of creating a storyboard is to visualize the narrative idea while describing the design of each screen in the instructional media. With a storyboard in place, the development process becomes more focused and aligned with the initial concept. Once the storyboard is finalized, the process continues with the creation of the media product using Microsoft PowerPoint integrated with the iSpring add-ins. Through iSpring, developers can incorporate various interactive elements such as audio, video, quizzes, and navigation features. The developed media in PowerPoint is then converted into an Android application using APK Builder software, making it accessible via smartphones.

The GEMA instructional media is designed with three main features: learning materials, educational games, and evaluation features. These features are developed to be as engaging as possible to enhance students' interest and involvement when using the media. This initial design is presented as a preliminary layout, which will later be refined based on feedback and suggestions from experts. The following is the initial layout design of the GEMA instructional media:

Table 4. Initial Design of GEMA Instructional Media Interface

Description	Storyboard	Preliminary Design
Home Screen		
Help Menu Screen		
About Screen		
Main Menu Screen		

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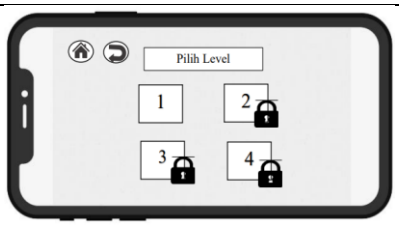
Description	Storyboard	Preliminary Design
Learning Material Menu		
Educational Game Menu Screen		
Assessment Menu Screen		

In the third stage, the development phase, validation tests were conducted by subject matter experts and media experts on the Android-based GEMA learning media. The validation results showed that this media has an excellent level of validity, with a percentage of 90% from each expert. Therefore, the GEMA learning media is deemed suitable for use as a supporting tool in mathematics education.

During the validation process, several suggestions were received and followed up with revisions to the media. One major revision was made to the question design, which initially did not account for a gradual increase in difficulty. Based on the experts' recommendations, the questions were restructured so that the level of difficulty increased as the game levels progressed, allowing for a more progressive development of the users' understanding.

In addition to content revisions, improvements were also made to the visual aspects. Initially, the game's opening screen only displayed a representation of one gender. Based on feedback from the media expert, this display was modified to feature both genders and added a character selection feature that allows users to choose their character before the game begins. As a result, the character used during the game can now reflect a more balanced gender representation. This revision aims to create an inclusive learning environment where all users feel represented and comfortable using the media, without any discriminatory impression towards a particular gender.

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(a) (b)

Figure 2. Revised Version

The fourth stage, implementation, consists of two types of trials: limited trials and field trials. In the limited trial, 10 students from class 10.D were involved outside of regular Learning Activities (KBM) time. After this trial, the students were asked to fill out a practicality sheet for the Android-based GEMA learning media. The results showed an average practicality score of 77%, indicating that the media is quite practical for use in mathematics instruction. In the field trial stage, 25 students from class 10.B were involved. The average practicality score obtained was 84%, which was higher than the limited trial. Additionally, after each meeting during the field trial, the students filled out a response sheet. In the first meeting, the response rate was 83%, while in the second meeting, the response slightly decreased to 80%.

The fifth stage in the development procedure of this instructional media is evaluation. Evaluation is carried out continuously at each development stage in accordance with the ADDIE model, starting from the analysis phase. At this stage, the researcher collects initial data and designs the media based on learning needs and input from the academic advisor. The initial design is then developed and validated by subject matter experts and media experts to ensure the content and visual presentation are appropriate. The validation results indicated several aspects that needed improvement, which were then addressed during the trial phase.

During the trial with students, several issues were identified that formed the basis for improvements, such as discomfort with the font type and size, as well as unappealing color choices. Therefore, the font was changed, the text size adjusted, and more suitable colors were selected to make the media more comfortable to use. In addition, students experienced difficulties accessing certain materials, so the media's navigation system was also adjusted to facilitate easier searching and increase learning efficiency. This evaluation process aims not only to ensure that the technical aspects of the media function well but also to align the media with user needs and preferences. As a result, the GEMA instructional media that was developed became more effective, engaging, and user-friendly for learning mathematics.

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Discussion

Based on the research findings presented, several aspects require further discussion, particularly concerning the effectiveness and challenges in using the Android-based GEMA learning media. The development of this media utilized the ADDIE model, which systematically produces a product aligned with learning objectives. Although GEMA has received very good validation from experts and positive responses from students, there are several important aspects that need to be examined more deeply.

One of the challenges identified in this study is the suboptimal use of technology in learning, even though most students already own smartphones. This condition highlights a gap between the potential of available technology and its application in classroom teaching and learning. Therefore, there is a need for innovative learning media that not only make optimal use of technology but also foster independent learning and capture students' interest. GEMA is designed as a relevant solution to address these challenges. By presenting the topic of function composition in an interactive and engaging format, GEMA is expected to enhance student engagement and optimize the use of smartphones as a fun and effective learning tool.

The trial results indicate that although GEMA received positive responses, there was a decline in enthusiasm during the second session. This suggests that while educational games can provide enjoyable learning experiences, the duration of gameplay and level of student engagement need to be carefully managed to maintain their effectiveness. Ronimus et al. (2014) noted that student attention tends to decline after 10 minutes, and Lujan and DiCarlo (2006) added that a significant drop can occur after 10–15 minutes of instruction. In addition to duration, the timing of implementation also affects enthusiasm levels; the first session was held during the first period when students were still fresh, while the second was held during the last period, when students were already tired. This is supported by Nursyaidah (2014), who stated that the learning process is influenced by various internal and external factors, such as physical and psychological condition, interest, fatigue, and the learning environment at home or school.

Although students gave positive feedback on the GEMA media, the learning outcomes did not fully reflect this. This shows that a positive attitude toward the media does not always directly correlate with improved learning outcomes. Hou and Li (2014) emphasized that the success of educational games in enhancing learning outcomes depends largely on the extent to which students experience a state of flow during the learning process. Therefore, further research is needed to identify the factors that can enhance students' flow experiences when using game-based learning media.

The primary goal of developing GEMA is to reduce students' dependence on teachers and to promote independent learning. However, although this media is designed to

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support self-directed learning, in reality, students still require guidance, especially when dealing with complex mathematical concepts such as function composition. Therefore, the teacher's role remains essential as a facilitator who guides and supports students throughout their use of this learning media. For future development of GEMA, several improvements need to be made, such as adjusting the gameplay duration to maintain student attention or dividing the game into smaller sessions to avoid fatigue. Enhancing interactive features that can foster a flow experience is also a key area to focus on. In addition, collaboration with app developers and educational psychologists could be a strategic step to create a more comprehensive and effective learning experience.

Overall, while the GEMA learning media has shown success in its development and validation stages, the challenges encountered during implementation and learning outcomes suggest the need for further attention. Appropriate adjustments can enhance the effectiveness of this media in supporting a more engaging, independent, and technology-integrated mathematics learning process.

Conclusion

The development of the GEMA (Game Edukasi Math Adventure) Android-based learning media using the ADDIE model has resulted in a valid, practical, and positively received media by students. This media is designed to present composition function material in an interactive and engaging manner, accessible via smartphones, thereby supporting more independent and enjoyable learning. However, the study results indicate that the effectiveness of the media is not solely dependent on its design quality and student acceptance, but is also influenced by external factors such as implementation timing, students' physical and psychological conditions, and limited attention spans during learning sessions. Furthermore, the teacher's role remains essential in guiding the use of the media, especially in delivering complex material. Therefore, further development of the GEMA media should consider aspects such as learning duration, interactive features that enhance the learning experience, and interdisciplinary collaboration to improve the overall effectiveness of the learning process.

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Conflict of Interest

The authors declare that no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely by the authors.

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