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ORIGINAL

Sikuadrat: Mathematics learning media with the Merdeka flow in solving quadratic equations and functions

Sikuadrat: Medios de aprendizaje de matemáticas con el flujo Merdeka para resolver ecuaciones y funciones cuadráticas

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ABSTRACT

The use of smartphones in education, particularly in mathematics learning for high school students, is becoming more prevalent as most students are familiar with Android-based devices. However, despite widespread access to smartphones, not all students utilize them as learning tools, and there remains a lack of engaging and interactive learning media tailored for this platform. This study aimed to develop and assess the effectiveness of "Sikuadrat," a mobile-based learning media focused on quadratic functions and equations. The media employs the MERDEKA instructional flow, designed to facilitate student engagement and understanding in solving quadratic equations. The development process followed the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. Data collection involved observations, interviews, documentation, and questionnaires, conducted with high school students and mathematics teachers at SMA 1 Klaten, Indonesia. The media's practicality and effectiveness were evaluated based on feedback from the participants. Results show that Sikuadrat is a highly valid and practical tool for enhancing the learning experience in mathematics, particularly for topics related to quadratic functions and equations. The media not only supports interactive problem-solving but also aligns with the instructional goals of mathematics education in high schools. In conclusion, Sikuadrat offers a valuable solution for integrating technology into mathematics learning and is suitable for implementation in high school curricula to support students' mastery of quadratic functions and equations, making it an effective and accessible learning tool for smartphone users.

Keywords: Android Learning Media; Media Development; MERDEKA Learning Flow; Quadratic Functions; Sikuadrat.

RESUMEN

El uso de medios de aprendizaje accesibles a través de teléfonos inteligentes para apoyar la educación matemática en escuelas secundarias (SMA) está en constante desarrollo. Aunque la mayoría de los estudiantes están familiarizados con los teléfonos inteligentes basados en Android, no todos los utilizan como herramientas educativas. Además, hay una carencia de medios de aprendizaje con flujos de instrucción atractivos. Este estudio tuvo como objetivo desarrollar y evaluar "Sikuadrat", un medio de aprendizaje accesible a través de teléfonos inteligentes, diseñado específicamente para la enseñanza de funciones y ecuaciones cuadráticas. El medio Sikuadrat sigue el flujo de instrucción MERDEKA, que promueve la participación activa de los

estudiantes en la resolución de problemas. El desarrollo del medio se basó en el enfoque ADDIE (Análisis, Diseño, Desarrollo, Implementación, Evaluación). La recopilación de datos se llevó a cabo a través de observaciones, entrevistas, documentación y cuestionarios, con la participación de estudiantes y maestros de SMA 1 Klaten, Indonesia. Los resultados indicaron que el medio Sikuadrat es altamente válido y práctico. La evaluación del uso del medio reflejó una mejora en la comprensión de los estudiantes respecto a las funciones y ecuaciones cuadráticas, demostrando la utilidad del medio en el entorno educativo. En conclusión, el medio Sikuadrat es una herramienta adecuada y efectiva para integrar el uso de teléfonos inteligentes en la enseñanza de matemáticas, facilitando el aprendizaje interactivo y el fortalecimiento de las habilidades de resolución de problemas en el ámbito de las funciones y ecuaciones cuadráticas.

Palabras clave: Medios de Aprendizaje de Android; Desarrollo de Medios; Flujo de Aprendizaje MERDEKA; Funciones Cuadráticas; Sikuadrat.

INTRODUCTION

Learning media play a crucial role in providing students with visual experiences, encouraging them to learn, and simplifying abstract or complex concepts to make them more easily understood.[1,2,3] In line with this statement, learning media with appealing presentations can facilitate students' understanding and mastery of content delivered by their teachers. Nowadays, various forms of media have rapidly evolved, including learning media that can be accessed through mobile devices.

Android-based learning media have been extensively developed. The integration of Microsoft PowerPoint and iSpring Suite (iSuite) on Android devices has been widely designed. The use of computer technology, such as Microsoft Powerpoint and iSuite, stimulates learning interest, motivates students to engage in learning activities,[4] and positively impacts the learning process.[5] However, not all technology-based learning media are practical, as they often require a computer or laptop for operation, and not all students have access to such devices. On the other hand, research on the development of Microsoft Powerpoint, APK Builder Pro, and iSuite has resulted in valid learning media for vector learning[6] and practical Android-based learning media for high school implementation.[7] Despite the validity and practicality of these media in enhancing students' motivation to learn, they often require internet access and significant storage capacity.

Given these challenges, it is essential to develop Android-based learning media that are both feasible and practical for students, with minimal storage requirements and offline accessibility, particularly for learning quadratic functions and equations in high school. Therefore, this study focuses on the development of Android-based learning media for quadratic functions and equations.

Interviews with a mathematics teacher in Klaten revealed that mathematics learning is primarily conducted using school textbooks, with Microsoft Powerpoint as the main learning media. Teachers still require skills to develop technology-based media, even though the school facilities, including installed LCDs and available computer labs, are adequate. Moreover, students are permitted to bring mobile phones to school, which could be leveraged to support mathematics learning through smartphone technology. Ideally, students should use smartphones to access learning materials from various sources, as these are crucial in the learning process.[8,9] However, the interview also indicated that most students face difficulties in understanding the concepts of quadratic functions and equations and struggle with solving contextual problems related to these topics. Typically, students find it challenging to distinguish between quadratic functions and equations, as well as between equivalent quadratic functions and equations.[10] Additionally, Android-based mobile phones are more widely used compared to other operating systems.[11] Despite this, most teachers do not extensively use Android-based mobile phones to develop learning media for mathematics instruction. The few teachers who have implemented such media often find them less engaging, resulting in reduced student motivation.[12]

It is, therefore, crucial to develop Android-based learning media to support high school students' learning. Addressing the issues mentioned above, it is anticipated that engaging Android-based learning media will help students better understand quadratic functions and equations and improve problem-solving skills. Moreover, this media can be implemented repeatedly, anywhere, and at any time students have the opportunity to learn. To achieve this, the content on quadratic functions and equations should be well-designed, presented with engaging features, and organized using a learning flow that motivates students to discuss, explore, and experiment.

This research aims to develop the Sikuadrat learning media by integrating Microsoft Powerpoint, iSuite, and APK Builder for teaching quadratic functions and equations in high school. Once developed, the Sikuadrat media will be analyzed for validity and practicality by experts. The Microsoft Powerpoint software serves as a tool for structuring content into presentation documents, while iSuite enhances the presentation with quizzes and games, converting it into an HTML format.[13] APK Builder, in turn, is used to convert the HTML format into an application.

The research on developing the Android-based Sikuadrat mathematics media addresses the following questions: (a) How is the Android-based Sikuadrat learning media designed for solving problems related to quadratic functions

and equations? and (b) How valid and practical is the Android-based Sikuadrat learning media for solving problems related to quadratic functions and equations? The development of this Android-based Sikuadrat learning media is expected to motivate students to learn mathematics. Additionally, this media is intended to serve as a reference for teachers in implementing innovative and creative learning strategies.

Literature Review

Instructional media can take the form of tools, methods, or techniques used as mediators between teachers and students to facilitate effective communication and interaction during learning activities.[14] According to other experts, instructional media can also encompass learning resources or physical tools used to convey the desired learning outcomes and to stimulate students' enthusiasm for learning.[13] Instructional media play a crucial role not only for students but also for teachers. They serve as educational tools for teachers to present learning topics, articulate learning objectives, outline learning activities, enhance students' creative skills, and foster students' attentiveness to the lessons.[15] Based on these explanations, the instructional media developed in this study will serve as visual tools or resources that teachers can use to deliver expected learning outcomes, content, or even game-based learning elements, making the learning experience more enjoyable. Additionally, students can utilize this instructional media as a learning resource that can be accessed repeatedly, thereby enhancing their motivation and creativity.

Several other studies have developed mathematics instructional media. For instance, research conducted by Handayani et al.[6] successfully produced an interactive Android-based instructional media by combining iSpring and APK Builder, which can be implemented in tenth-grade mathematics on the topic of vector projection. This research shares similarities with the present study, as both involve the development of Android-based instructional media using a combination of iSpring and APK Builder applications.[6] However, the content differs, as this study focuses on media for middle school students. On the other hand, a study developed and produced interactive Android-based mathematics instructional media for teaching three-dimensional geometry, specifically on the position of lines and planes in space, for tenth-grade students.[6] This media was developed using Adobe Flash, whereas the current study utilizes Microsoft PowerPoint, iSpring Suite, and Website 2 APK Builder. Another relevant study successfully developed Android-based mathematics instructional media using Construct 2 software for seventh-grade students. This study shares a common approach with the present research in using the ADDIE development model. However, the difference lies in the software used; while the previous study employed Construct 2, this research implements Microsoft PowerPoint, iSpring Suite, and Website 2 APK Builder.

In addition to the aforementioned studies, the researcher has conducted several preliminary studies to support the development of this Android-based instructional media. Previous research has analyzed students' difficulties in understanding the solution of quadratic functions and equations. Some of these difficulties include students' inability to organize problems, failure to comprehend the problems, and the lack of varied problem-solving strategies.[16,17] Another study identified various aspects and factors influencing mathematics learning outcomes, such as students' concentration and learning environment,[18] while mathematics learning motivation was found to be influenced by several factors, including health.[19] In another factor analysis study, it was concluded that instructional media is a crucial aspect for students in participating in learning.[20] Previous research also involved the development of instructional media using Microsoft PowerPoint, where activities such as creating videos with Microsoft PowerPoint and FastStone were implemented in the learning process.[21,22]

METHOD

Study Design

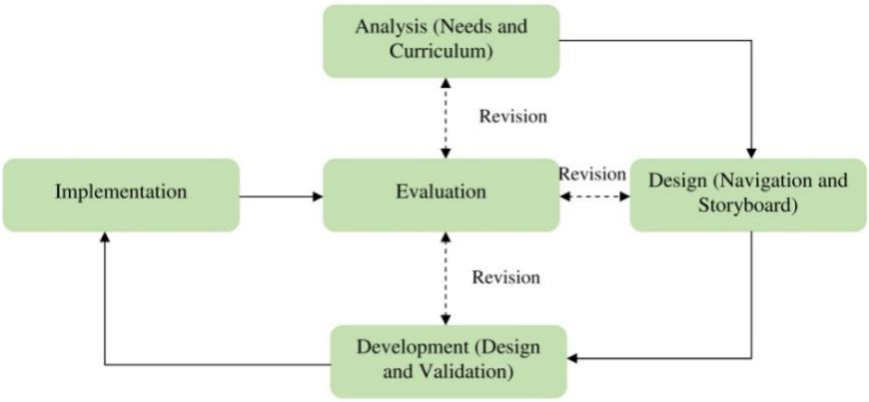

Figure 1. ADDIE research and development design

This study develops an instructional media product using the ADDIE procedure as described by Dick and Carey,[23] which includes analysis, design, development, implementation, and evaluation. The research will be conducted up to the stages of design and validation. The ADDIE development design for this study is illustrated in figure 1.

Procedure

In each research activity, data is collected from subjects, including students, teachers, and experts. The data in this study is gathered through observation, interviews, and questionnaires. Observations during classroom learning and interviews with teachers and several students at SMAN 1 Klaten, Indonesia provide information about the requirements for developing instructional media, such as the necessary hardware and software. Additionally, curriculum analysis is conducted to determine the competencies, content scope, content depth, and expected learning outcomes for teaching quadratic functions and equations. Following this, data on the media's feasibility is collected through questionnaires completed by two media experts and two subject matter experts.

The subjects of this research include media experts, content experts, practitioners, and high school students. They were involved in collecting data during both the needs analysis and feasibility analysis (validity and practicality) stages. The objects of the study are the learning activities and the Android-based mathematics learning media. Data were collected from these subjects through teacher interviews, classroom observations, documentation, and questionnaires. Classroom observations and interviews with teachers and students provided insights into the needs for designing the learning media, such as the number of students, learning resources used by students and teachers, and the learning media utilized by the teachers. Additionally, curriculum analysis offered information on students' abilities, learning outcomes, scope and depth of material, and the expected learning achievements for quadratic equations and functions. Questionnaires were distributed to media experts, content experts, and users (high school students). For media and content experts, the questionnaires aimed to assess the suitability of the media and its alignment with the quadratic equations content. For high school students, the questionnaires were used to evaluate the practicality of the Sikuadrat learning media. The alignment of the research steps, data collection, research subjects/objects, and data analysis is summarized in the following table 1.

Table 1. Alignment of research steps with data collection and analysis

Research Steps	Data Collection	Subjects/Objects of Study	Data Analysis
Needs Analysis	Observations, Interviews, Documentation	Teachers and Students at SMA N 1 Klaten, Mathematics Learning Content, Quadratic Functions and Equations, Student Facilities	Qualitative Descriptive
Media Design	Literature Review, Documentation, Observations	Sikuadrat Media	Qualitative Descriptive
Development (Validity Analysis)	Questionnaires	2 Content Experts, 2 Media Experts	Quantitative Descriptive
Implementation (Practicality Analysis)	Questionnaires	Students at SMA N 1 Klaten, Teachers at SMA N 1 Klaten	Quantitative Descriptive
Evaluation	Observations	2 Content and Media Experts	Qualitative

Instrument

The instruments used in this study include observation sheets, interview guides, and questionnaires, designed to collect comprehensive data for the validation and practicality analysis of the instructional media. The observation sheets were employed during classroom observations to assess teaching practices and students' learning needs, focusing on how quadratic functions and equations are taught. Interview guides facilitated structured discussions with teachers and students, providing insights into the existing challenges and needs for developing effective learning media. Lastly, questionnaires were administered to media experts, content experts, and students. The questionnaires for experts aimed to evaluate the media's content validity and technical quality, while the student questionnaires measured the practicality and usability of the developed media in actual learning environments. These instruments were essential in ensuring that the media met both the pedagogical and practical requirements for effective use in mathematics education.

Inclusion and Exclusion Criteria

The inclusion criteria for this study encompass high school students currently enrolled in grades 10 and 11 at SMA 1 Klaten, Indonesia, specifically those studying quadratic functions and equations. Additionally, mathematics teachers from the same school who possess relevant experience in teaching these topics and

are willing to provide feedback are included. Media and content experts with qualifications in mathematics education or instructional design are also eligible to participate. Participants must be available throughout the study, including during data collection phases such as observations, interviews, and questionnaire completion, and must provide informed consent to participate. Conversely, the exclusion criteria specify that students not enrolled in SMA 1 Klaten or those in grades other than 10 and 11, teachers who do not specialize in mathematics, and experts lacking relevant qualifications will be excluded. Furthermore, students and teachers from other schools or those not engaged in learning quadratic functions will not be considered. Participants unable to commit to the study's timeline or who do not provide informed consent will also be excluded, ensuring that the study targets suitable participants and contexts for obtaining relevant data on the effectiveness of the developed instructional media.

Data Analysis

The collected data were analyzed using both qualitative and quantitative descriptive analysis. Data gathered through observations, documentation, and interviews were analyzed qualitatively, while data collected via questionnaires were analyzed quantitatively. During the needs analysis and media design steps, data were analyzed qualitatively.

The designed media was then validated by experts to obtain the validity results of the media. Validity information for the learning media was collected through questionnaires filled out by media and content experts. In this study, validators included media specialists, mathematics education experts, and mathematics teachers. Feedback and suggestions from these experts served as a basis for improving (evaluating) the developed media, and this was analyzed using qualitative descriptive methods. The validity and practicality measures obtained were used to determine the appropriateness of the learning media through percentage values.[24] Quantitative descriptive analysis was employed to calculate these percentages.

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

The level of feasibility for each indicator is determined according to feasibility criteria. A percentage of 80 to 100 is categorized as "very good," 60 to 79 as "good," 40 to 59 as "fairly good," 20 to 39 as "bad," and 0 to 19 as "very bad."

Development Media Design

The design of the Android-based instructional media begins with mapping out navigation that depicts the relationship between various instructional media content and the storyboard (media flow). The instructional media is then designed following the steps outlined in figure 2.

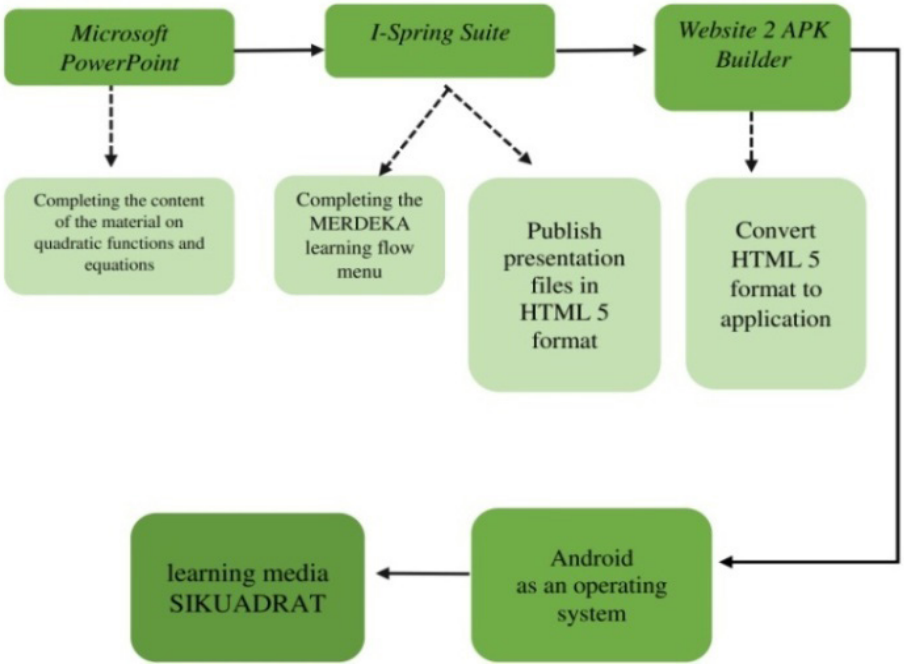

Figure 2. Instructional media design

The mathematics learning media that has been developed is named Sikuadrat. Initially, the content on quadratic functions and quadratic equations is designed in Microsoft PowerPoint using attractive fonts, shapes, animations, and images, with hyperlinks added to buttons. The instructional media logo is created using the Canva application available on smartphones or laptops, with a mocha base color and a media mascot image. In the next step, quiz menus are designed using iSpring Suite 10, incorporating feedback for correct and incorrect answers. Before the presentation file is published, it is enhanced with background music and thoroughly checked using the preview feature in the ribbon. After this review, the PowerPoint presentation file is published in HTML5 format using iSpring Suite 10. Finally, the HTML5 file is converted into an application format using the Website 2 APK Builder Pro.

Ethical Criteria

The ethical criteria for this study are established to safeguard the integrity and welfare of all participants involved in the research. Informed consent will be obtained from students, teachers, and experts prior to their participation, ensuring they are fully aware of the study's purpose, procedures, potential risks, and benefits. Confidentiality will be upheld by anonymizing personal information and data to protect participant identities. Participation will be entirely voluntary, allowing individuals to withdraw at any time without facing any consequences. The research will adhere to institutional guidelines and regulations concerning ethical practices, including review by an ethics committee or institutional review board. Any potential conflicts of interest will be disclosed to maintain transparency. Overall, the study aims to conduct research with respect and sensitivity towards all participants, fostering an environment of trust and collaboration while upholding the highest ethical standards in educational research.

RESULTS

Requirements for Sikuadrat Learning Media

Data on the needs for the developed Sikuadrat learning media were collected through observations and interviews. Observations revealed that the learning process employs lecture and discussion methods, remains teacher-centered, and that the material presented by the teacher is not contextualized and consists only of formulas. The learning media implemented by the teacher includes smartphone-based media solely for task submission and PowerPoint presentations but lacks a structured learning flow. Students have smartphones, most of which are Android-based, and also have laptops, but these are used only for certain lessons. Interviews with mathematics teachers at SMA N 1 Klaten, Indonesia provided insights into the learning system, curriculum, mathematics content, and smartphone media. The interviews highlighted the need for engaging content on learning media, including contextual material, games, quizzes, and a structured learning flow.

Design of Sikuadrat Learning Media

Component		(Firdaus et al., 2023)	(Maryana et al., 2019)	(Handayani & Rahayu, 2020)	(Yuliana et al., 2023)	(Bahari et al., 2023)	(Rildayani et al., 2022)	**Media Sikuadrat**
Application	Ppt	-	√	√	√	-	√	√
	Ispring suite	-	√	√	√	-	-	√
	Apk bulider	-	-	√	√	-	-	√
	Others	√	-	-	-	√	-	
Topics	Math	√	√	√	√	-	√	√
	Science	-	-	-	-	-	-	-
	Others	-	-	-	-	√	-	-
Subject	Elementary School	-	-	-	-	√	-	-
	Junior High School	-	√	-	√	-	-	-
	High School	√	-	-	-	-	√	√
	College	-	-	√	-	√	-	-
Focus	Critical	-	-	-	-	-	-	-
	HOTS	-	-	-	-	-	-	-
	Achievement	-	√	√	-	-	-	√
	Solving	-	-	-	√	√	√	√
	Literacy	√	-	-	-	-	-	-
Content	Material	√	√	√	√	√	√	√
	Practice	√	√	√	√	√	√	√
	Quiz	-	√	-	√	-	-	√
	Game	-	-	-	√	-	-	√
Operating system	Android	Yes	Yes	Yes	Yes	No	No	Yes
Learning Flow	Merdeka	No	No	No	No	No	No	Yes

Figure 3. Theoretical framework (literature review) for designing sikuadrat media

The literature review has been compiled as a basis for designing the Sikuadrat learning media. The results of the literature review are presented in figure 3.

The designed product results in an Android-based mathematics instructional media that can be implemented for teaching quadratic equations and functions in the tenth grade. This instructional media utilizes three different applications. Despite the integration of Microsoft PowerPoint, iSpring Suite 10, and Website 2 APK Builder Pro, the media is not difficult to assemble. Additionally, the implementation of this media is user-friendly; it features an attractive interface, can be used offline, and does not require substantial storage space. The introduction to the instructional media includes a 7-second loading screen, followed by a welcome screen with a tagline from the developers, a mascot, and a "Start" button to navigate to the main menu. The developer page provides the identity of the developers and the opening page includes a welcoming message. This learning media is named SIKUADRAT, with a quadratic graph logo as shown in figure 4.

Figure 4. Sikuadrat media logo

The developed Sikuadrat media incorporates the MERDEKA learning flow. This flow facilitates students in discussing, experimenting, and creating products.This instructional media follows the MERDEKA flow, which consists of several learning steps: self-introduction, concept exploration, collaborative space, demonstration, understanding elaboration, material connections, and real action.

- Self-Introduction: this section includes pre-assessment activities such as introductory questions, concept knowledge, and pre-tests. It provides students with an opportunity to learn about the benefits of quadratic functions and their applications in everyday life, presented attractively through images and contextual phenomena related to quadratic functions.
- Concept Exploration: this phase allows students to delve into various concepts related to quadratic functions and equations. It includes material explanations, examples, exercises, and quizzes with solutions, which further reinforce students' understanding of quadratic functions and equations.
- Collaborative Space: this is where students work in groups to discuss and solve contextual problems related to quadratic functions.
- Contextual Demonstration: this menu allows students to present their work and discuss the results of their group discussions.
- Elaboration Understanding: students deepen their understanding of quadratic functions through elaborative activities. This section provides opportunities for students to explore additional information about quadratic functions from other learning resources and to summarize their findings.
- Material Connections: this space allows students to create posters about quadratic functions, showcasing their creativity.
- Real Action: this phase gives students the chance to test their understanding of quadratic functions through posters and group experiments conducted outside the classroom.

Each menu in the instructional media serves a distinct purpose and presents different content. The main menu has been modified based on feedback from media experts, featuring a dark blue background with symbols representing the learning steps. The text size and buttons on the main menu have been enlarged to draw users' attention. The main menu page of the instructional media is shown in figure 5. The information page of the instructional media includes the expected learning outcomes for quadratic equations and quadratic functions. The subsequent information page features a menu for the Pancasila student profile.

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Figure 5. Main menu page of the instructional media

In the MERDEKA flow for learning activities, the "Self-Introduction" section includes apersepsi, prompting questions, concept knowledge, and pre-tests. This section allows students to learn about the benefits and real-life applications of quadratic functions through engaging images and contextual phenomena (figure 6).

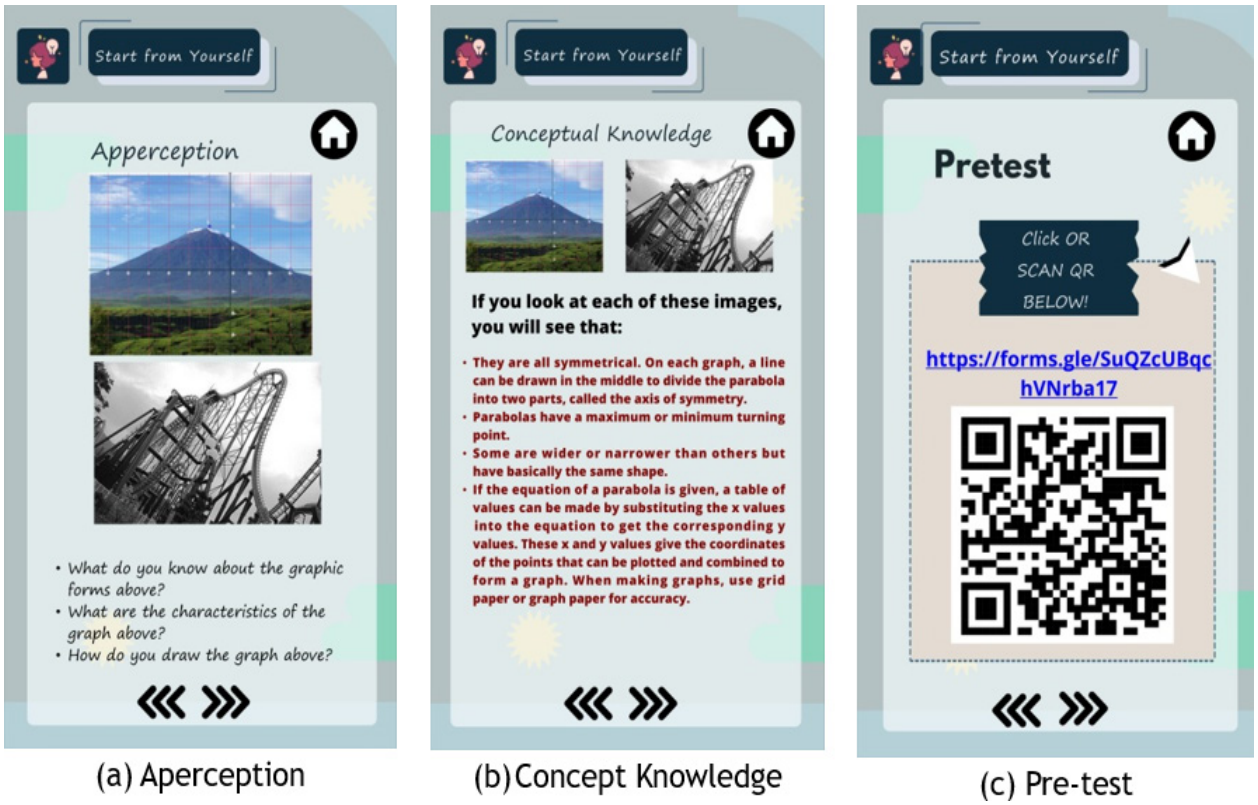

Figure 6. Self-introduction menu page

The "Concept Exploration" menu is designed for students to explore various concepts related to quadratic functions. It includes material, examples, exercises, and quizzes with solutions to reinforce students' understanding of quadratic equations and functions (figure 7).

The "Collaborative Space" menu enables students to work in groups to discuss and solve contextual problems related to quadratic functions and equations. The class is divided into 4-5 groups, and this section also provides discussion steps. The "Demonstration" menu serves as a platform for students to present their work and the results of their group discussions. Groups are given the opportunity to present their findings to the class.

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Figure 7. Concept exploration menu page

The "Understanding Elaboration" menu provides students with opportunities to delve deeper into quadratic functions through additional resources (figure 8). Students can scan barcodes to access YouTube videos, summarize their learning through provided options, and reflect via QR codes linking to Google Docs.The "Material Connections" menu allows students to create posters about quadratic functions, showcasing their creativity. Two examples of quadratic functions and equations are provided for reference.

Figure 8. Understanding elaboration menu page

The "Real Action" menu provides students with opportunities to test their understanding of quadratic functions and equations through post-tests and group experiments conducted outside the classroom (figure 9). The post-test evaluates students' understanding via QR codes or links to Google Docs. The experimentation section includes clear steps for students to follow in creating group projects outside the classroom.The "Closing" menu includes motivational content encouraging students to remain enthusiastic about learning.

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Figure 9. Real action menu page

Practicality, Validity, and Evaluation

According to expert validators, both the media and content aspects of this learning media are considered excellent. The questionnaires provided to content and media experts included suggestions, comments, and evaluations. The evaluation of this learning media was based on indicators such as visual appearance, software engineering, content relevance, organization, assessment, language, and the overall usefulness of the media.[25] The data from the experts' evaluations were then analyzed descriptively to determine the media's feasibility. The results of the media expert evaluation are presented in table 2, while the content expert evaluation results are shown in table 3.

Table 2. Media evaluation

Indicator	Score (%)	Criteria
Visual Appearance	92	Very Good
Software Engineering	90	Very Good
Language	100	Very Good
Usefulness	100	Very Good
Average	95,5	Very Good

Table 3. Content evaluation

Indicator	Score (%)	Criteria
Content Relevance	98	Very Good
Content Organization	96	Very Good
Evaluation/Exercises	98	Very Good
Language	100	Very Good
Usefulness	100	Very Good
Average	98,4	Very Good

Based on the evaluation by media experts, the average score percentage obtained was 95,5 %, while the content experts' assessment yielded an average score of 98,4 %. Both evaluations fall into the "very good" category. According to the media criteria (appearance, software engineering, language, and usefulness) and content criteria (relevance, organization, evaluation, language, and usefulness), this educational media is

deemed suitable for implementation in teaching quadratic functions and equations. This is consistent with other relevant studies, which have concluded that Android-based educational media has met the required standards of feasibility,[4,6,7] as evidenced by scores above 60 % for each indicator.[25]

The practicality assessment of the educational media was tested on 64 tenth-grade students at SMA N 1 Klaten, Indonesia using a questionnaire. The students' assessment of the media's practicality consisted of 20 evaluation items, including 5 items on ease of use, 6 items on appearance, 5 items on text readability, and 4 items on usefulness. The scoring used a Likert scale ranging from 1 to 5, with each evaluation criterion having a maximum score of 5. The classification of the students' evaluation data is presented in table 5.

Table 5. Practicality assessment by students

Indicator	Score (%)	Criterion
Ease of Use	92	Very Good
Appearance	91,14	Very Good
Text Readability	95	Very Good
Usefulness	97,18	Very Good
Average	93,83	Very Good

DISCUSSION

The developed educational media is equipped with graphics, photographs, animations, and background sound, aligning with previous research that indicates such media helps students absorb, process, and reorganize messages visually and verbally to achieve mathematical learning objectives.[2,26] Additionally, this Android-based educational media is designed attractively with the MERDEKA learning framework, enhancing students' enthusiasm, interest in learning, and engagement. This is consistent with research which found that Microsoft PowerPoint and iSpring Suite-based educational media can boost students' learning enthusiasm, interest, and interaction with teachers through engaging media presentations.[4]

The Sikuadrat media includes an apperception menu. This apperception connects the material with the application of quadratic functions in everyday life and provides a pretest to assess initial abilities. Through this apperception, students gain an initial understanding of quadratic functions, recognize the benefits of studying quadratic functions, and recall fundamental concepts related to quadratic functions. In the Sikuadrat media, quadratic functions are illustrated using visuals such as the trajectory of a Ferris wheel and a mountain shape from a distance, resembling a parabola. The pretest is used to recall students' initial understanding of quadratic functions and equations. Initial abilities are crucial to address before solving mathematical problems,[27,28,29] as foundational knowledge of algebra and linear functions is necessary for understanding and solving quadratic functions.

The Sikuadrat media also provides a knowledge elaboration menu through brief-answer questions. Students are asked to answer questions about quadratic functions and equations using various provided keywords. This activity helps students become accustomed to identifying keywords before solving problems related to quadratic functions and equations, such as the axis of symmetry, maximum value, inflection points, and the direction of the parabola opening.[30] In addition to identifying keywords, students are encouraged to use various problem-solving strategies. The Sikuadrat media presents solutions to quadratic functions and equations through graphs, tables, formulas, experiments, and sketches.

Furthermore, the Sikuadrat media enhances student learning activity through the MERDEKA learning flow. Students are encouraged to study independently, collaborate with peers, explore additional learning resources, conduct experiments, and present results through products. These learning activities contribute to improving problem-solving skills for quadratic functions and equations or critical thinking abilities.[31,32,33]

Moreover, the educational material menu is presented in simple language, incorporating contextual problem-solving strategies and quizzes that aim to broaden and deepen students' understanding of quadratic functions and equations. The material menu clearly, sequentially, attractively, and systematically presents quadratic functions and equations. The quiz menu offers problems related to quadratic functions and equations along with their solutions. Students can tackle these problems using various problem-solving strategies, such as tables, diagrams, and sketches. This approach helps students become accustomed to solving problems using different learning strategies. This is consistent with previous research indicating that problem-solving is related to the strategies used.[34,35] By providing diverse problem-solving strategies, this educational media aims to facilitate students' familiarity with solving quadratic functions and equations.

In addition to the educational material, this learning media includes a game menu designed to make learning more enjoyable for students. Through the game menu, students can learn about mathematical figures and concepts in a fun way, which is expected to enhance their motivation and interest in studying mathematics.[36,37]

In addition to the engaging content, quiz sections, and game menu, the learning media enhances student activity by allowing repeated access. This feature supports increased student engagement in learning quadratic functions and equations. This finding aligns with research indicating that Android-based learning media fosters greater student activity compared to traditional teaching methods.[38,39] The developed learning media is highly flexible, as it can be used on both laptops and smartphones, with links easily shared via WhatsApp or transferred via software without needing internet access. The file size required for transfer is also minimal. This supports other studies that describe smartphone-based learning media as more flexible.

In terms of content, this learning media is limited to quadratic functions and equations for 10th-grade high school students. However, future research could develop similar media (adapting the menus and interface) for other topics.

CONCLUSIONS

This research has developed Android-based mathematics learning media by integrating Microsoft PowerPoint, iSpring Suite, and APK Builder. The Sikuadrat mathematics learning media is designed to operate on Android smartphones.The Sikuadrat learning media features various menus, including information, content, quizzes, and games. It is anticipated that these features will enhance students' enthusiasm, interest, and engagement in learning.The learning media developed in this study incorporates the MERDEKA learning flow, which includes stages such as self-assessment, concept exploration, collaborative space, demonstration, elaboration of understanding, connections between topics, and real-world actions.Additionally, the media presents content that includes contextual problems and step-by-step solutions for quadratic equations. This approach aims to simplify the process of solving contextual problems for students.

Evaluations by media and content experts indicate that this learning media is highly feasible and practical for implementing quadratic functions and equations. It is hoped that teachers will use this media as a tool to deliver the learning objectives for quadratic functions and equations. The media is designed to be user-friendly and accessible, featuring engaging visuals, interactive elements, and a well-structured learning path. The inclusion of a game section aims to enhance student motivation and interest in mathematics by providing a more enjoyable learning experience. The flexibility of this media allows it to be used across various devices, including laptops and smartphones, with minimal storage requirements.

Future research could expand this media to cover additional mathematical topics, enhancing its applicability in a broader range of educational settings. Furthermore, incorporating multimedia elements such as instructional videos and interactive simulations could enrich the learning experience and support diverse learning styles. Ensuring compatibility with all operating systems would also increase the accessibility and usability of the media for a wider audience. Ongoing development and refinement of this educational tool are essential to address emerging needs and technological advancements. By continually updating and improving the media, educators can better support student learning and engagement in mathematics.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Yuliana.
Data curation: Yuliana, Tasari
Formal analysis: Tasari.
Research: Yuliana.
Methodology: Tasari.
Project management: Yuliana.
Software: Nughthoh Arfawi Kurdhi.
Supervision: Yuliana.
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