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Development of learning media using Desty assisted by Desmos for the quadratic function in 9th grade

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Abstract: The background of this research is the need for more interactive and visual learning media to help students understand abstract concepts, such as quadratic functions, which are often difficult to understand with conventional media. This research aims to develop technology-based mathematics learning media using the Desty platform assisted by Web Desmos on quadratic function material for grade 9 junior high school students. The method used in this research is Research and Development (R&D). The development of learning media was carried out through Thiagarajan's 4D model which consists of defining, designing, developing, and dissemination stages. This study only covers up to the development stage, where validation was conducted by experts without field trials due to restrictions caused by the COVID-19 pandemic. The results showed that the media developed were valid and feasible to use for learning, with the average validation results being in the valid category. The use of this media is expected to improve students' understanding of quadratic function material through clearer and interactive visualization.

Keywords:
Desty, Junior High School, Learning Media, Quadratic Function, Web Desmos

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1. Introduction

In today's digital age, the use of technology in education has become a primary focus to improve the quality of learning (Haleem et al., 2022; Wijaya et al., 2022). This transformation includes not only the introduction of new tools and resources but also changes in how students interact with subject matter. In mathematics learning, particularly with quadratic functions, the challenges students face often stem from the concept's abstract nature. Many students have difficulty in understanding and applying complex mathematical concepts, which can result in low motivation and interest in learning.

One solution to overcome this challenge is to develop more interactive and visual learning media (Hokanson, B., & Gibbons, 2016). This research aims to develop technology-based learning media that utilize the Desty platform combined with Web Desmos (Isroil et al., 2022). The combination of these two platforms is expected to create a more interesting and effective learning experience for grade 9 students (Dürlinger & Pietschnig, 2022). Interactive

learning media can help students better understand abstract concepts by providing clear visualizations and direct interaction with the material.

Based on previous research, the use of the Desmos application in mathematics learning has been shown to improve students' understanding of the concept of function (Dikkartin Ovez, 2018). However, the research has not specifically developed media integrated with other platforms, such as Desty, to create more interactive and thorough learning. In addition, research by Lavidas et al. (2022) shows that many learning media still rely on static visualizations, which cannot provide a dynamic and engaging learning experience for students. Therefore, this research seeks to fill the gap by developing a learning media that combines the advantages of both platforms.

The importance of developing learning media that utilize digital technology is also supported by various studies showing that integrating technology into learning can increase student engagement and facilitate a better understanding of the subject matter. According to Viberg et al. (2023), the use of technology in education supports the development of 21st-century competencies, in which students are expected to have strong digital literacy and ICT skills (Rini et al., 2022). Thus, the development of innovative and interactive learning media will not only help students understand difficult math concepts but also prepare them to face challenges in an increasingly digital world (Marini et al., 2022; Nasrullah et al., 2022; Suripah & Susanti, 2022).

In the context of education in Indonesia, especially at the junior high school level, the use of technology-based learning media is still relatively low (Sanusi Siregar et al., 2018). Many schools still rely on conventional learning methods that are less attractive to students (Cholily et al., 2021). This is a challenge for educators to create a conducive and interesting learning atmosphere. Therefore, this research focuses on developing learning media to overcome these problems by leveraging existing technology.

In this study, the authors used the Research and Development (R&D) method to develop effective and valid learning media (Indariani et al., 2018). The development process follows Thiagarajan's 4D model, which includes defining, designing, and developing learning media (Kimianti & Prasetyo, 2019). By involving expert validators in the evaluation process, the resulting media is expected to meet high-quality standards and be ready for use in classroom learning.

With this background, this study aims to develop Desty-based learning media, supported by Web Desmos, for the quadratic function material and to evaluate the media's effectiveness and validity in improving students' understanding. It is expected that the results of this study will make a positive contribution to improving the quality of mathematics learning at the junior high school level and encourage the wider use of technology in education.

2. Methods

This research uses the Research and Development (R&D) method to develop mathematics learning media on quadratic functions using the Desty platform and Web Desmos (Hodiyanto

et al., 2020). The approach used in this research is a combination of quantitative and qualitative. Quantitative data were obtained from validation sheets completed by validators, while qualitative data were collected through documentation, interviews, and validators' criticisms and suggestions. The subjects of this study were ninth-grade students at SMP Negeri 2 Panyipatan, with the objective of developing learning media to improve students' understanding of the quadratic function material.

Media development was conducted using Thiagarajan's(1976) 4D model, which consists of four main stages: defining, designing, developing, and disseminating. However, this study only covers the development stage, with validation conducted by experts without field trials due to COVID-19-related restrictions. The development of learning media in this study follows the following steps.

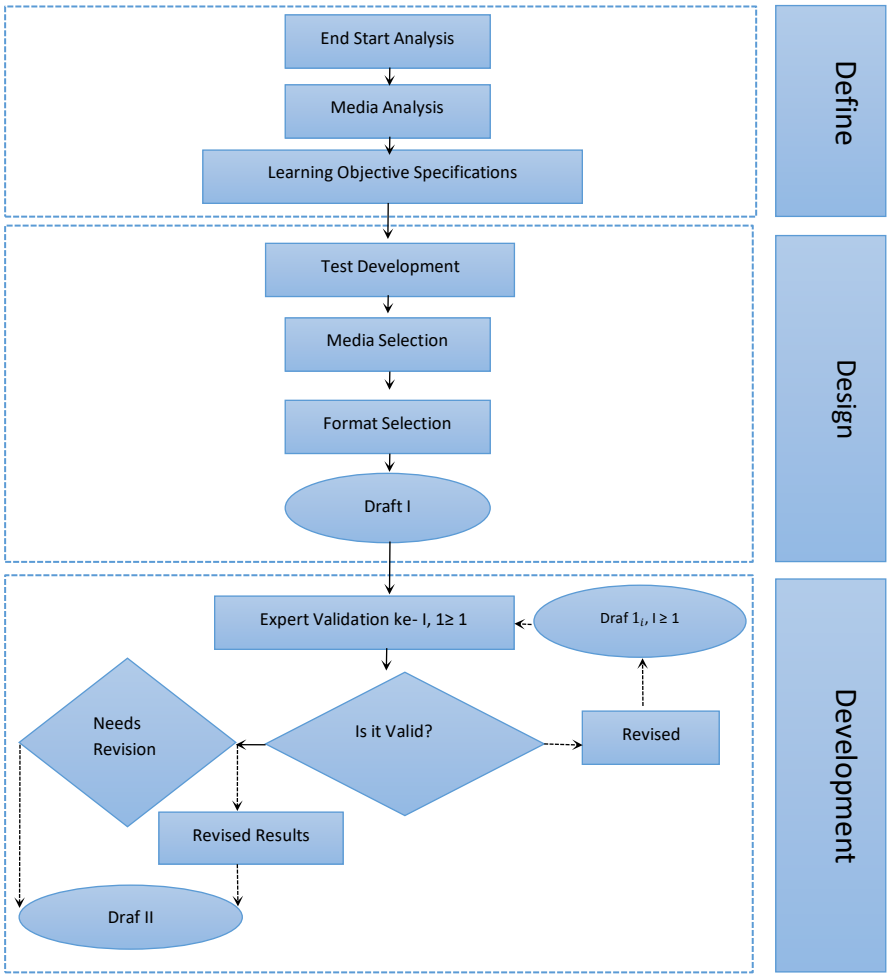

Figure 1. Development Steps of the 4-D Model

In the defining stage, needs analysis, media analysis, and specification of learning objectives are conducted. The design stage involves preparing test instruments, selecting appropriate media and formats, and developing the initial design of learning media. Furthermore, during the development stage, the initial design (Draft I) was validated by four experts, comprising three Mathematics Education lecturers and a mathematics teacher. The assessment was conducted across three main aspects: format, content, and language, to

evaluate the quality and validity of the developed media. The data obtained were then analyzed to assess the media's validity, using a five-level scale as a reference.

Table 1. Interval of Validity and Learning Plan

No	Average Expert Rating	Criteria
1	$1 \leq V_a < 2$	Invalid
2	$2 \leq V_a < 3$	Less Valid
3	$3 \leq V_a < 4$	Valid enough
4	$4 \leq V_a < 5$	Valid
5	$V_a = 5$	Very Valid

The results of this validation are used to make revisions and to produce Draft II, which is expected to meet the validity criteria and be ready for use in learning. This method aims to produce learning media that is valid, of high quality, and able to support mathematics learning, especially on the quadratic function material.

3. Results and Discussion

In the defining stage of this research, several analyses were carried out to determine the needs and specifications for the development of Desty- and Web Desmos-based quadratic function learning media. 1) End-start analysis: Students often have difficulty understanding abstract concepts in quadratic functions, which is reflected in the low results of the national mathematics exam. The research site has never used Desty media, and learning still relies on simple media such as LKS books. Therefore, interactive media is needed to improve the quality of learning. 2) Media analysis: Computers and Androids were chosen as media due to their popularity among students and their ability to visualize abstract concepts in mathematics through digital simulation. 3) Task analysis: The tasks are based on the basic competencies of the 2013 curriculum for grade IX, specifically related to quadratic functions, and can be accessed through Google Forms to facilitate evaluation. 4) Concept analysis: The materials developed focus on determining quadratic functions through tables, equations, and graphs, in accordance with the basic competencies set.

The design stage comprises several important steps: test preparation, media selection, format selection, and initial media design. (1) Test preparation: Tests are prepared to measure students' competence in understanding and presenting quadratic functions using tables, equations, and graphs according to learning objectives. (2) Media selection: Computers were chosen as the main media because of their ability to visualize abstract concepts, which makes learning mathematics easier to understand. Desty and Desmos were chosen for their features that support visualizing quadratic functions. (3) Format selection: The format of the media was tailored to the needs of visuals and easy use, with fonts and layouts that adjust to the menus available in Desty and Desmos. (4) Initial media design: The media was created using the Desty Website, Google Forms, and Microsoft PowerPoint with a design that prioritizes ease of navigation and aesthetics, using a blue background and color variations in the content elements.

In the development stage (develop), after the learning media have been produced as the first draft (Draft I), expert validation is conducted to ensure the media's feasibility. This validation involved two material expert validators and two media-specific validators. 1) Material validation: The validators assessed the quality of the content and objectives, as well as the learning quality of the media. Based on their assessment, the material received an average score of 4.45, which falls into the valid category. Recommendations for improvement included enhancing the pictures or graphs of functions in the example problems, as they were too small and unclear. 2) Media validation: Media validation was conducted by four validators, who assessed the display design and media programming. The media received an average score of 4.43, which falls within the valid category. Some suggestions for improvement were given, such as reorganizing the main menu to make it more systematic and improving the instructions for use by adding pictures and explanations of button functions in the media. This revision resulted in a final product that is more valid and ready to be used for learning

Based on these suggestions, revisions were made to the first draft. The changes included those presented in Table 2.

Table 2. Suggestions from Validators

No	Improvement Points	Validator Feedback
1	Improvement of the Main Menu Sequence	The order of the main menu which was previously “material - syllabus - discussion - task - calculator - hint” was changed to “hint - calculator - syllabus - material - discussion - task” to improve systematization.
2	Improvements to the Instructions Frame	The instructions that were originally only in the form of a table were improved by adding pictures and explanations about the function of each button.
3	Improvements to Learning Materials	Graphics and materials that were previously too small and unclear were enlarged and clarified to make it easier for students to understand.

In making this media, the researcher used Thiagarajan's modified 4D development model and limited it to only a few stages. These stages include the defining, design, and development stages. The initial stage of learning media development is the defining stage, which includes end-start analysis, learner analysis, task analysis, concept analysis, and specification of learning objectives. At this stage, the researcher analyzes the condition of the school used as the research subject, UN scores, and other relevant research. Based on the analysis that has been done at this stage, it is known that there are still many students who do not understand the subject matter of the quadratic function, on the grounds that there are too many formulas that must be remembered, and the class teacher's statement, as revealed through direct interviews. Given their limitations, students' thinking is often less able to capture and respond to abstract or previously unrecorded information. that the proportion

of students' errors in solving math problems about quadratic functions.

The next stage in the development of this media is the design stage, which includes test preparation, media and format selection, and initial design work. At this stage, tests based on indicators of achieving objectives were prepared, and Desty and Desmos were chosen as media because they have features that can visualize mathematical material, including quadratic functions, in the format used. The media was created using the Desty Website, Google Forms, and Microsoft PowerPoint. The result of this design is a media framework. The media is made with resolution and the general font, and it adjusts to the menu available in media making, specifically for making instructions and a syllabus using LM Roman 18 and Computer Modern. The media background on each page is blue, with color variations in the media content elements. The page can be accessed at http://desty.page/yazidi/vidiopembelajaran.

Figure 2. Initial Display Frame

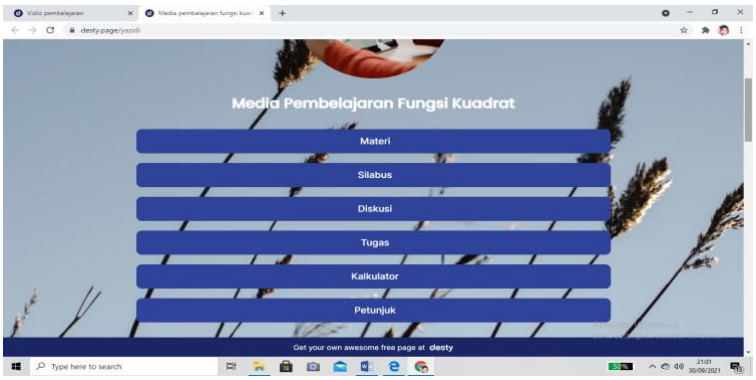

Figure 3. Menu Display

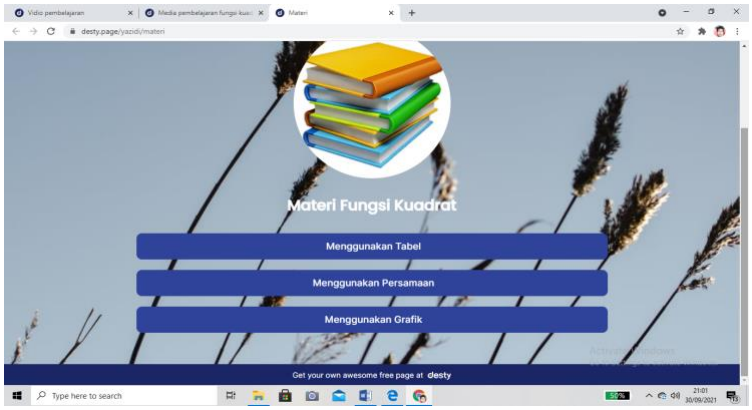

Figure 4. Material Frame

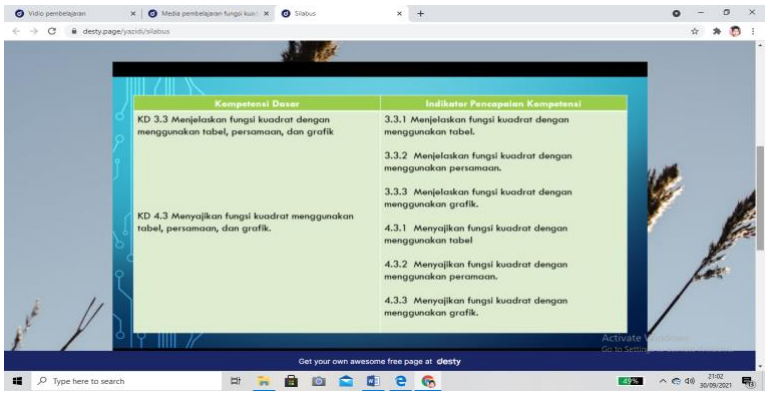

Figure 5. Discussion Frame

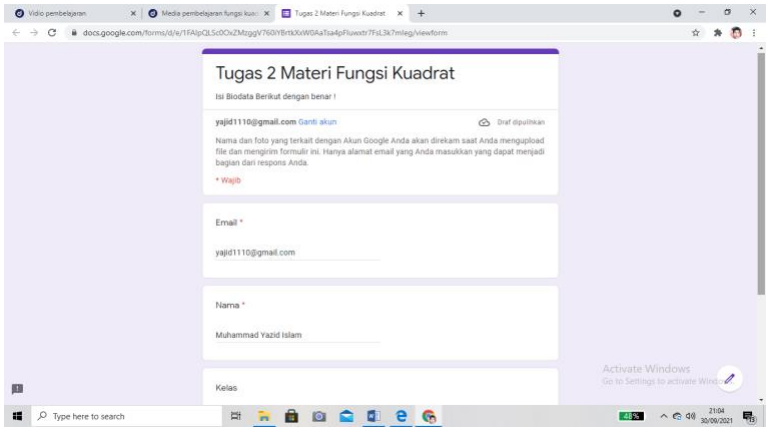

Figure 6. Task Frame

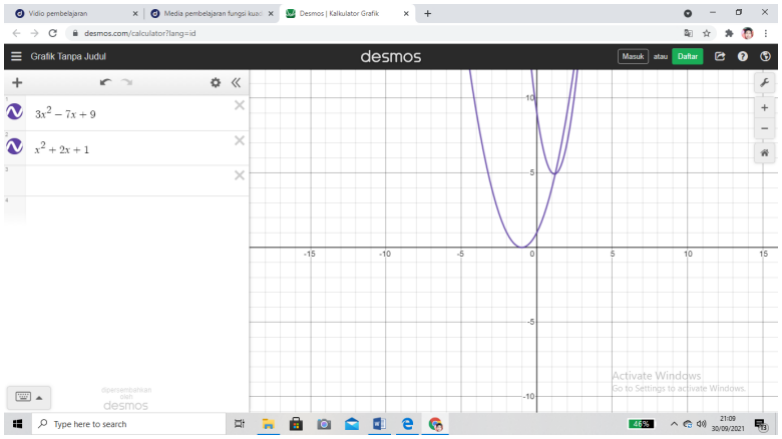

Figure 7. Calculator Frame

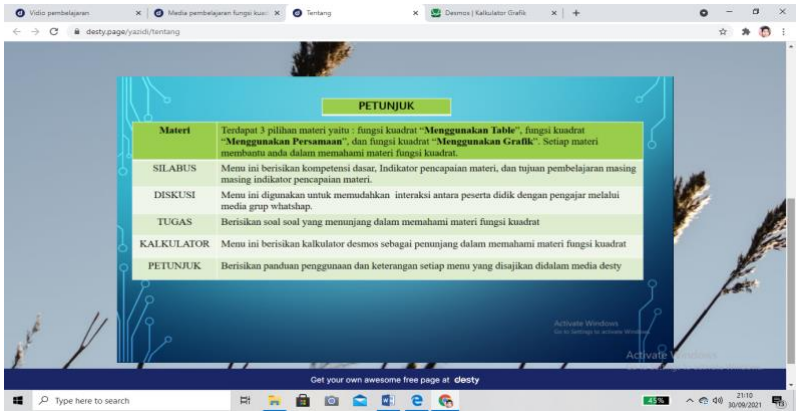

Figure 8. Instruction Frame

The last stage is the development stage, which includes improving the media draft based on the validity test. The validators required for the development of this media consisted of two material expert validators, two media expert validators, and two special validators for the media. The validation results for the quality aspects of the content and objectives obtained an average of 4.4 in the valid category. This shows that the concepts and materials presented have met the demands of the curriculum on derivative materials and the learning objectives to be achieved. The aspect of learning quality obtained an average of 4.5 in the valid category. This shows that the components in this learning media draft are complete, enabling students to understand the material well and independently. The validation results for the design/appearance aspect obtained an average of 4.44 with the valid category. This shows that the learning media's design is attractive and easy to use. The programming aspect obtained an average of 4.41 in the valid category. This shows that this learning media is easy to use. Overall, the material aspect received a score of 4.45, and the media aspect received a score of 4.43, indicating that the digital media, assisted by Web Desmos for the researcher-developed quadratic function material, was declared valid.

This research is novel in developing mathematics learning media using the Desty platform, assisted by Web Desmos, especially for the quadratic function material for grade 9 junior high school students. This novelty can be seen from the combination of two platforms

that have not previously been widely applied simultaneously in learning mathematics at the junior high school level. While previous research, such as that conducted by Herlina (2022), demonstrated the effectiveness of the Desmos application in mathematics learning, this study extends this by integrating the Desty platform to create more interactive learning. In addition, previous studies that focused on static visualization (Lavidas et al., 2022), did not take advantage of the interactive features offered by Web Desmos and Desty. Thus, this research offers a new approach in improving students' understanding of abstract mathematical concepts through more interactive and engaging visualizations.

The development of technology-based learning media, such as that conducted in this study, is highly relevant to current educational needs (Setyaningrum & Waryanto, 2018). In the context of mathematics learning, especially on quadratic function material, the use of interactive media such as Desty and Desmos can help students understand abstract concepts that are often a challenge (Dikkartin Ovez, 2018). Previous research shows that the use of digital media can improve students' understanding of complex mathematical concepts (Rittle-Johnson, B., & Star, 2007). With clearer, more interactive visualizations, students can more easily grasp the relationships among graphs, tables, and equations, which are at the essence of quadratic functions.

In addition, it is important to consider the context of the applicable curriculum. The media developed in this study not only aims to improve students' understanding but also to meet curriculum standards that require students to apply mathematical concepts in real-world situations (Kurniawan & Kuswanto, 2021; Suripah & Susanti, 2022). According to previous studies, students often experience low levels of motivation when conventional learning media are used (Asigigan & Samur, 2021; Suripah & Susanti, 2022). Therefore, integrating technology into learning can help increase student motivation and engagement.

However, the challenges in implementing this media in the classroom also need to be considered. Although the media have been validated by experts, their successful use depends largely on teachers' readiness to integrate technology into their teaching. Research shows that training and professional development for teachers are essential to ensure that they can effectively utilize technology in learning (Richards, 2015). Therefore, it is important to design training programs that support teachers in using these media, so that they can optimize students' learning experience.

Furthermore, feedback from media users also provides valuable insights for further improvement. In this study, validators provided suggestions to improve the visual quality and instructions for using the media. This is in line with findings showing that good design and clear instructions can increase the effectiveness of learning media (Sumarwati et al., 2020). By paying attention to this feedback, media development can be carried out iteratively to produce a final product that is more valid and ready for use in a learning context (Nida et al., 2020; Setiawan et al., 2022).

One important aspect of learning media development is student engagement in the learning process. Research shows that when students are actively involved in learning, they tend to have a better, deeper understanding of the material being taught. In the context of

using Desmos and Desmos Media, the interactivity these platforms offer allows students to actively explore quadratic function concepts. For example, students can manipulate the parameters of the graph to see how changes affect its shape, which can strengthen their understanding of the properties of quadratic functions.

In addition, it is important to consider the role of collaboration in learning. Well-designed learning media can support collaborative learning, where students work together in groups to solve math problems. Research by Amalia & Hadi (2023) shows that collaborative learning not only improves academic understanding but also students' social skills. By using interactive media, students can discuss and share ideas, enriching their learning experience. Therefore, the development of learning media that supports collaboration between students is very important.

On the other hand, the challenges of using technology in education cannot be ignored. Although technology-based learning media offer many advantages, they also carry risks, such as dependence on technology and accessibility issues. Arikarani & Amirudin (2021) highlight that the digital divide can be a barrier for students who lack equal access to technology. Therefore, it is important to ensure that all students have equal opportunities to use these learning media, both by providing adequate devices in schools and by training students to use technology effectively.

Finally, continuous evaluation of the effectiveness of the developed learning media is also very important. This research only covers the development and validation stages, but to ensure that the media is truly effective in improving students' understanding, further research involving field trials is needed (Flores-Cáceres et al., 2022). Evaluation involving feedback from students and teachers can provide valuable insights for further improvement. Thus, the learning media development cycle should include not only the initial stage, but also the evaluation and revision stages to achieve optimal results.

4. Conclusion

This study successfully developed Desty-based mathematics learning media assisted by Desmos Web on the quadratic function material for junior high school grade IX. The resulting media was considered valid by experts in both material and design, with a high average score in the valid category. The use of this medium is expected to help students understand abstract concepts, such as quadratic functions, through interactive visualizations provided by Desmos. The novelty of this research lies in the integration of the Desty platform and Web Desmos, which has not been widely applied before, especially at the junior high school level.

Overall, the development of this technology-based learning media shows significant potential in improving students' understanding. The involvement of students in an active, collaborative learning process is key to enhancing the effectiveness of this medium, allowing them to interact with the material and with each other, thereby building a deeper understanding. However, challenges such as the digital divide and dependency on technology need to be addressed to ensure equitable access for all students. Continuous evaluation of the learning media's effectiveness is also crucial, with field trials and feedback from students

and teachers providing valuable insights for further improvement. Through the development of this media, it is expected to make a positive contribution in improving the quality of mathematics learning in the digital era and supporting the development of necessary 21st century skills for students.

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