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THE DEVELOPMENT OF CANVA-ASSISTED SCIENTIFIC APPROACH PYTHAGORAS TEACHING MATERIALS TO IMPROVE STUDENTS' MATHEMATICAL REASONING ABILITY ON JUNIOR HIGH SCHOOL

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ABSTRACT

This research was conducted to determine the development, feasibility, effectiveness, and difficulties in the development of teaching materials on the Pythagorean Theorem using a scientific approach assisted by Canva to enhance the mathematical reasoning abilities of junior high school students. This research was conducted at SMP PGRI 10 Bandung using the Research and Development (R&D) method based on the 4D stages. The research subjects included 33 students from class IX F for limited trials, 27 students from class VIII B, and 29 students from class VIII D for extensive trials. The research instruments used in this study included interviews in the preliminary learning, student responses to the teaching materials, expert validation sheets, and 6 items of reasoning ability test questions. The material used in this research was the Pythagorean Theorem. Student reasoning ability test data were analyzed using Microsoft Excel calculations. The research results indicate that: 1) the development process of the 4D method teaching materials, including a) Define (Definition); b) Design; c) Develop; and Disseminate, have been successfully implemented according to the plan; 2) the validator calculation results obtained a percentage of 86.21%, categorized as "very valid and do not need revision"; 3) the student reasoning ability test results prove that the teaching materials are reasonably effective; 4) significant difficulties include students' lack of understanding of the material, low activity, and a lack of supportive learning facilities.

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INTRODUCTION

Numerous benefits accrue when a teacher develops their own teaching materials. These advantages include the following: Firstly, it results in teaching materials that align with curriculum requirements and cater to students' learning needs. Secondly, it liberates educators from dependence on textbooks, which can sometimes be challenging to obtain. Thirdly, it enriches teaching materials by drawing upon various references and sources. Fourthly, it enhances teachers' knowledge and experience in crafting educational content. Fifthly, it fosters effective learning communication between teachers and students, as students tend to trust their instructors more when they use personalized teaching materials (Magdalena et al., 2020).

Mathematical reasoning, defined as the ability to connect problems to ideas systematically, plays a vital role in education (Salmina & Syarifah, 2018). According to Gustiadi et al. (2019), reasoning is a thinking process that links facts or concepts to draw conclusions. Kusumawardani (2018) further asserts that reasoning is a fundamental skill in mathematical literacy, highlighting its importance in solving mathematical problems. Therefore, mathematical reasoning, in the context of this research, refers to the ability to think critically and solve mathematical problems.

Ariati & Juandi (2022) suggest several indicators of mathematical reasoning skills, such as presenting mathematical statements orally, in writing, or through diagrams, making conjectures, manipulating mathematical concepts, drawing conclusions, providing evidence, and evaluating the validity of arguments.

Additionally, they mention the importance of recognizing patterns or properties in mathematical phenomena for generalization. The significance of mathematical reasoning for students is multifold: It allows students to explain and present mathematical statements using various mediums. It enables them to make logical conjectures and draw well-founded conclusions. It aids in recognizing patterns and generalizing situations.

According to Kurnia et al. (2019), mathematics education in schools is guided by six fundamental principles: equity, curriculum, teaching, learning, assessment, and technology. Mathematics learning encompasses five core mathematical competencies, known as the five process standards: problem-solving, reasoning, communication, connection, and representation.

The 2018 Programme for International Student Assessment (PISA) results, as reported by Hewi & Saleh (2020), indicate fluctuations in Indonesian students' abilities. In reading, Indonesian students achieved an average score of 371, ranking 74th, lagging behind Thailand (68th), Malaysia (58th), and Singapore (2nd). In mathematics, Indonesia scored an average of 379, ranking 73rd, trailing behind Thailand (58th), Malaysia (48th), and Singapore (2nd). Regarding science, Indonesia scored an average of 396, ranking 71st, falling behind Thailand (54th), Malaysia (49th), and Singapore (2nd). These results suggest that the objectives of mathematics education in Indonesia have not been fully met and are closely linked to students' reasoning abilities (Konita et al., 2019).

Despite the importance of mathematics, it is often perceived as abstract and difficult by students. Therefore, improving mathematical reasoning skills is crucial for optimal learning outcomes (Marfu’ah et al., 2022).

As Akbar et al. (2018) argue, reasoning is a crucial tool not only in mathematics but also in everyday life. Hence, students with strong reasoning skills can comprehend mathematical concepts accurately and generate ideas effectively.

To address these challenges, researchers must employ appropriate teaching methods. In this study, a scientific approach will be used. Wulandari et al. (2013) define a scientific approach as a teaching method involving five processes, commonly known as the 5M: observing, questioning, experimenting, reasoning, and communicating.

Creating engaging teaching materials requires creativity to capture students' interest effectively. Thus, enhancing students' mathematical reasoning abilities often entails using various teaching models.

Educational media serve as valuable tools for conveying information and stimulating student interest. Canva, for instance, simplifies the presentation of textual and visual learning materials, making the learning process more engaging (Rahmayanti & Jaya, 2020).

The introduction of the Pythagorean theorem to eighth-grade students often poses challenges, as many struggle with this topic. Common errors include miscalculating quadratic operations, misidentifying the hypotenuse when the diagram changes, and erroneous operations when given the length of the hypotenuse and one side (Milla & Wulan, 2018). To address these issues, it is necessary to develop teaching materials for Pythagoras' theorem using a scientific approach tailored to seventh-grade students. This approach involves various stages: orientation, core activities (identifying problems, data collection, data processing, proof, and drawing conclusions), and closure (Zagoto & Dakhi, 2018).

This approach encompasses three domains: attitude, skills, and knowledge, which together contribute to fostering creativity in mathematics learning. Therefore, educators must develop creative and innovative teaching materials to enhance students' learning motivation (Irmawati et al., 2023).

Irkhamni et al. (2021) suggest that the Canva application strengthens students' interest in learning, particularly in mathematics, thanks to its attractive templates, designs, colors, and fonts.

Canva serves as a technology-based learning tool that provides educators with creative templates for posters, graphics, brochures, presentations, logos, videos, book covers, and more. This aligns with Pasmawangi et al.'s (2023) assertion that developing mathematics teaching materials using Canva eases the creation of appealing and high-quality learning content.

This research aims to develop, assess the quality, evaluate the effectiveness, and identify challenges in developing teaching materials for Pythagoras' theorem using a scientific approach and Canva to enhance students' mathematical reasoning skills in middle schools. The teaching materials will consist of worksheets (LKPD) designed based on the scientific approach's stages, including orientation, core activities, and closure (Zagoto & Dakhi, 2018).

The quality of the developed teaching materials will be assessed through expert validation, limited trials, and extensive trials, with a focus on competence, material presentation, alignment with relevant elements, and benefits to students as evaluated by experts and practitioners.

Effectiveness will be measured by comparing pre-test and post-test results after using the teaching materials in the product trials. This will gauge the extent to which the teaching materials enhance students' mathematical reasoning skills in the context of Pythagoras' theorem.

This research endeavors to offer a valuable resource for educators and students facing challenges in comprehending Pythagoras' theorem. Ultimately, it aims to elevate students' learning outcomes by enhancing their mathematical reasoning abilities.

METHOD

The research conducted falls within the scope of Research and Development (R&D) with the objective of developing instructional materials using Canva. Consequently, the resulting product constitutes innovative instructional materials aimed at enhancing students' reasoning abilities. The research process adheres to the 4D development stages outlined by Fajri & Taufiqurrahman (2017), as illustrated in Figure 1 below:

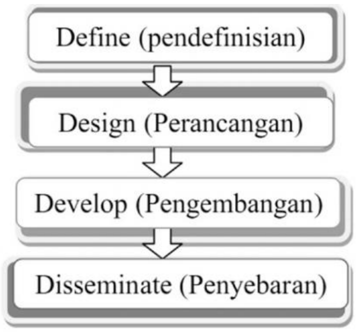


Figure 1. 4D Development Stage Diagram

1. **Define Stage:** This initial phase involves defining the research. During this stage, the researcher conducts interviews with mathematics teachers to gain insights into the school's situation and conditions based on accurate information from reliable sources.
2. **Design Stage:** In this phase, the researcher determines the content, learning objectives, and designs instructional materials in the form of Learning Tools for Problem Solving (LKPD) using Canva. Instruments are also created to assess the developed instructional material's design.
3. **Develop Stage:** During this phase, the researcher has developed LKPD materials with the assistance of Canva. The instructional material's design aligns with the researcher's expectations, rendering it ready for testing with students. Subsequently, the instructional material undergoes validation and revision by experts, including content specialists, media experts, and mathematics subject teachers. This validation aims to assess the appropriateness of the developed instructional material.
4. **Disseminate Stage:** This final stage entails the utilization of the developed instructional material, which has been tested with students. The instructional material has been revised in line with the suggestions provided by expert validators and practitioners. The dissemination of this material occurred in Class VIII B and VIII D at SMP PGRI 10 Bandung.

The research was conducted at SMP PGRI 10 Bandung in November 2022, with follow-up activities in January 2023 due to the implementation of Periodic Assessment (PAS). The subjects of this research comprised 33 ninth-grade students for the limited trial and 56 eighth-grade students for the extensive trial. Validators in this research included media experts, content specialists, and mathematics subject teachers.

The validation of the instructional materials is assessed based on data obtained from validation questionnaires completed by the experts. The validation results are presented as percentages, calculated using the formula, and categorized according to product validation criteria.

Percentage of Validity = (Mean Score Obtained) / (Expected Score) × 100%

Table 1. Product Validation Criteria

Percentage (%)	Criteria
81% - 100%	Very Valid (usable without revisions)
61% - 80%	Reasonably Valid (usable with minor revisions)
41% - 60%	Less Valid (not recommended for use due to significant revisions needed)
21 % - 40%	Not Valid (not recommended for use)
0% - 20%	Very Not Valid (not allowed for use)

To determine the effectiveness of the instructional materials, pre-test and post-test results from students are analyzed. The test results measuring reasoning abilities are presented as average scores and calculated using the normalized gain (N-gain) test, as per Husein et al. (2017).

$$N\ Gain = \frac{Skor\ Posttest - Skor\ Pretest}{Skor\ Ideal - Skor\ Pretest}$$

Table 2. N-Gain Effectiveness Interpretation Categories

Percentage (%)	Category
$N\ Gain < 40$	Not Effective
$40 < N\ Gain \leq 55$	Less Effective
$56 < N\ Gain \leq 75$	Reasonably Effective
$N\ Gain > 76$	Effective

RESULTS AND DISCUSSION

Results

The results of this research entail the development of instructional materials in the form of Learning Tools for Problem Solving (LKPD) aided by Canva. The research adhered to the 4D development process, encompassing Define, Design, Develop, and Disseminate phases.

Define Phase: This stage involved initial analyses, including interviews with mathematics teachers. The key findings included: 1) Existing teaching approaches and methods were not fostering active learning; 2) Inadequate facilities and resources; 3) Teachers primarily relied on students' supplementary textbooks; 4) The curriculum followed was the 2013 curriculum. Additionally, the analysis of student characteristics revealed: 1) Difficulty comprehending fundamental concepts; 2) Low participation and enthusiasm during lessons; 3) Subpar learning outcomes; 4) Minimal utilization of ICT in math education; 5) Student boredom due to a lack of creativity in teaching.

Design Phase: During this phase, the researcher selected the content, focusing on the Pythagorean Theorem, and utilized ICT-based platforms such as Canva and PowerPoint for instructional material development. The aim was to create engaging instructional materials that would facilitate student comprehension and maintain their interest. The researcher also designed validation sheets to assess the developed instructional materials. These validation sheets would be completed by media experts, content specialists, and mathematics teachers. Students would also provide feedback through questionnaires to assess their responses and the practicality of using Canva-supported LKPD.

In this phase, the LKPD design is created using Canva, as illustrated in Figure 2. You can access it through this link:

https://www.canva.com/design/DAE9Q2HcpLo/AnGaXfYJ0ivSUsVsADtP2Q/edit?utm_content=DAE9Q2HcpLo&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton.

Additionally, PowerPoint is employed to enhance the appeal of the teaching materials, harnessing the capabilities of both ICT platforms, as demonstrated in Figure 3.

Figure 2. Canva-Based Instructional Material Design

Figure 3. PowerPoint-Based Learning Media Design

Before conducting student trials, the instructional materials underwent validation. Validation assessments were performed by media experts, content specialists, and mathematics teachers to identify and rectify any deficiencies in the developed instructional materials.

Media expert validation aimed to assess the suitability of Canva-supported LKPD materials. Aspects evaluated by media experts included content validity, presentation quality, and language usage, as detailed in Table 3.

Table 3. Media Expert Validation Results

No	Aspect Evaluated	Score	Percentage	Category
1.	Content Validation	3,70	74%	Reasonably Valid
2.	Presentation Validation	3,67	73,4%	Reasonably Valid
3.	Language Validation	3,40	68%	Reasonably Valid
	Total Average Score	3,59	71,8%	Reasonably Valid

The table above illustrates that content validation achieved a 74% score, presentation validation reached 73.4%, and language validation scored 68%. The overall percentage obtained from media expert validation was 71.8%, categorized as reasonably valid.

Validation by content specialists involved assessing content validity, presentation quality, and language usage, with results presented in Table 4.

Table 4. Content Specialist Validation Results

No	Aspect Evaluated	Score	Percentage	Category
1.	Content Validation	4,67	93,4%	Very Valid
2.	Presentation Validation	4,75	95%	Very Valid
3.	Language Validation	4,60	92%	Very Valid
	Total Average Score	4,67	93,4%	Very Valid

The table reveals that content validation achieved a 93.4% score, presentation validation reached 95%, and language validation scored 92%. The overall percentage obtained from content specialist validation was 93.4%, categorized as very valid.

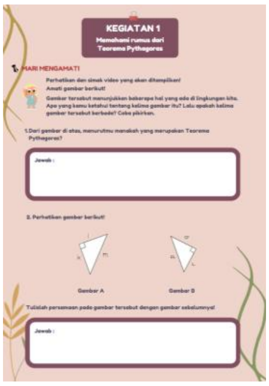
Validation by mathematics teachers assessed user-friendliness, presentation attractiveness, and usefulness. The results are presented in Table 5.

Table 5. Mathematics Teacher Validation Results

No	**Aspect Evaluated**	**Score**	**Percentage**	**Category**
1.	User-Friendliness	4,5	90%	Very Valid
2.	Presentation Attractiveness	4,75	95%	Very Valid
3.	Usefulness	4,75	95%	Very Valid
	Total Average Score	4,67	93,4%	Very Valid

The table shows that user-friendliness achieved a 90% score, presentation attractiveness reached 95%, and usefulness scored 95%. The overall percentage obtained from mathematics teacher validation was 93.4%, categorized as very valid

Based on feedback from media expert validators, revisions were deemed necessary. These included corrections to terminology and enhancing student motivation with motivational statements. Suggestions from content specialist validators highlighted the importance of enabling students to adapt group discussion outcomes and assigning homework to deepen their understanding of class materials. Additionally, modifications to the LKPD layout were suggested to provide clearer guidance for solving problems, as illustrated in Figure 4.


Before Revisions


After Revisions

Figure 4. LKPD Before and After Revisions

Following the validation process and subsequent adjustments in line with expert recommendations, limited and extensive trials were conducted to evaluate the usability of the developed instructional materials. These trials involved distributing response questionnaires to students to gauge their feedback regarding the instructional materials. In this testing phase, 33 ninth-grade students participated in the limited trial, and 56 eighth-grade students took part in the extensive trial. The summarized student responses for both trials are presented in Table 6.

Table 6. Summary of Student Responses in Limited and Extensive Trials

Limited Trial		**Extensive Trial**	
Percentage	**Category**	**Percentage**	**Category**
78%	Feasible	83%	Very Feasible

According to the table above, the limited trial yielded a 78% percentage, categorized as feasible, while the extensive trial resulted in an 83% percentage, categorized as very feasible.

The subsequent stage is the dissemination phase. The results from expert and practitioner validation confirmed that the developed instructional materials meet the standards required for effective teaching. Therefore, the instructional materials developed by the researcher can be trialed with students.

Discussions

In the development of instructional materials, researchers inevitably encounter challenges throughout the entire developmental process, from the initial Define phase to the Disseminate phase. This discussion aims to explore the instructional material development process, its feasibility, and its effectiveness in the context of education.

During classroom instruction, it is often observed that students exhibit limited responsiveness to the subject matter being taught. This issue is pervasive across various classrooms. As a response, strategies to actively engage students during learning, such as Q&A sessions and discussions, have been employed. Hasanah (2018) emphasizes that educators must proactively employ teaching methods to encourage active student participation, fostering interaction, inquiry, and the expression of ideas.

Furthermore, students often display confusion regarding the instructional media used by researchers to convey the subject matter. Consequently, preliminary guidance is provided to familiarize students with the forthcoming learning process. Nurjanah et al. (2020) support this approach, highlighting that teachers guide students, set examples, and offer advice during classroom instruction.

The statement above underscores the importance of time management in education, as students can become engrossed in practical applications of the subject matter. Therefore, researchers must offer concise yet comprehensible explanations. By packaging these explanations attractively within media formats, students can effectively assimilate the taught material (Amalina, 2020).

Student comprehension challenges often stem from a lack of interest in learning. Consequently, students struggle to grasp concepts, leading to overall difficulty in understanding the subject matter. This aligns with the findings of Ritonga & Hasibuan (2020), who identify a lack of student interest as one of the potential sources of math learning difficulties, particularly in understanding fundamental concepts.

Low student engagement in the classroom often stems from feelings of shyness and a lack of self-confidence when researchers engage students in questioning. Students may not be accustomed to verbally articulating their ideas or may be hesitant to ask questions. Consequently, these factors affect their participation and learning capabilities during the instructional process. Zakiyatin (2021) concurs, noting that low student engagement in various studies is a common issue affecting learning outcomes.

The absence of available equipment, such as an infocus projector, during lessons presented a challenge, requiring researchers to adapt their strategies to ensure the smooth progression of instruction. Inadequate school facilities necessitated contingency planning to ensure uninterrupted learning processes. Sugiarto et al. (2021) argue that limited and insufficient facilities should not serve as excuses for teachers to neglect their duties; instead, they should serve as motivation to enhance the quality of education within their schools.

Mashuri & Budiyono (2020) posit that the suitability of a teaching medium hinges on the results of feasibility tests. Feasibility testing, involving aspects like competency, material presentation, relevance to related elements, and utility, must precede a medium's evaluation. Before undergoing feasibility tests, educational media must undergo validation, where experts in the field, including media and subject matter specialists, provide recommendations for enhancing media quality. Consequently, based on the results of validation testing conducted in collaboration with expert validators and practitioners, the instructional materials achieved acceptable ratings in the limited trial and were deemed highly acceptable in the extensive trial.

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According to Setiyorini et al. (2017), data collected comprise scores from assessments by subject matter and media experts, documented on validation sheets. Critical research aspects include competence, material presentation, suitability of instructional materials to relevant components, and utility.

During practitioner testing, students were asked to complete response questionnaires and questionnaires prepared by the researcher. Students assessed various aspects using multiple indicators. Based on the validation trial data from practitioners, ratings reached 72% for the limited trial and 93% for the extensive trial. It can be concluded that all aspects of the limited trial were rated as "Valid," and for the extensive trial, all aspects achieved a "Highly Valid" rating.

The effectiveness of instructional materials for teaching the Pythagorean Theorem using PowerPoint, applying a scientific approach to eighth-grade students' reasoning abilities, was determined through reasoning tests administered as part of the student assessment.

In the evaluation phase, students completed Pre-Test and Post-Test assessments provided by the researcher. The compilation of student evaluations, which determined the effectiveness of the developed instructional materials, indicated that the instructional materials were categorically "Effective."

This concurs with Gustiwati et al. (2020), who state that evaluating instructional materials is crucial to determine their effectiveness. Effectiveness is gauged by observing learning activities and students' initial reading abilities. The dissemination phase involves implementing the instructional materials developed in different contexts, such as other classes or schools, to test their effectiveness on distinct subjects. Instructional materials are considered effective if they yield positive learning outcomes and contribute to achieving the intended educational objectives.

In summary, the analysis of reasoning test results reveals that the developed instructional materials effectively enhance students' understanding of the Pythagorean Theorem. Consequently, the research achieves the goal of enhancing students' mathematical learning through a scientific approach.

CONCLUSION

The development method of instructional materials in the form of Canva-assisted worksheets (LKPD) was executed through four phases: Define, Design, Develop, and Disseminate. Evaluation by experts and practitioners rendered the development of Canva-assisted instructional materials both highly valid and effective for educational use. Consequently, Canva-assisted instructional materials can serve as an innovative learning medium in mathematics education. Future researchers are encouraged to further enhance Canva-assisted instructional materials, with the expectation that the refined media will yield even better results in the learning process.

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