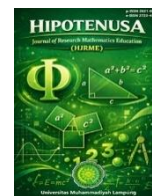


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Developing canva-based educational animation videos on the pythagorean theorem to improve junior high school students' mathematical communication

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ABSTRACT

The mathematical communication skills of junior high school students are still relatively low, which impacts students' difficulties in understanding and conveying mathematical concepts accurately. This study aims to develop a valid, feasible, and effective Canva-based educational animated video media on the Pythagorean Theorem material in improving students' mathematical communication skills. This study used the Research and Development (R&D) method with the ADDIE model. The research subjects consisted of three expert validators and 22 eighth-grade students of SMP IT Insan Robbani. Data were collected through expert validation sheets as well as pretest and posttest tests. The results showed that the media obtained a validity percentage of 88.89% with a very valid category. The average student pretest score of 37.27 increased to 69.09 in the posttest, with an N-Gain value of 0.51 indicating an improvement in students' mathematical communication skills. Observations also showed that students were more active in drawing, writing down solution steps, and compiling explanations systematically. Thus, Canva-based educational animated video media is effective for improving students' mathematical communication skills.

1. Introduction

Mathematical communication skills can be understood as students' ability to convey and explain mathematical ideas and thought processes clearly and structuredly, both verbally and in writing, so that the mathematical ideas conveyed are easy to understand. This understanding is in line with the opinion [1] which states that mathematical communication skills are students' ability to convey and explain mathematical ideas, concepts, and solutions

verbally and in writing through symbols, diagrams, tables, graphs, and mathematical language. Thus, mathematical communication skills are an important competency to be developed in mathematics learning. The importance of mathematical communication skills is also emphasized in the Minister of Education and Culture Regulation Number 21 of 2016 concerning Elementary and Secondary Education Content Standards which states that students are expected to have the ability to communicate mathematical ideas clearly and effectively [2].

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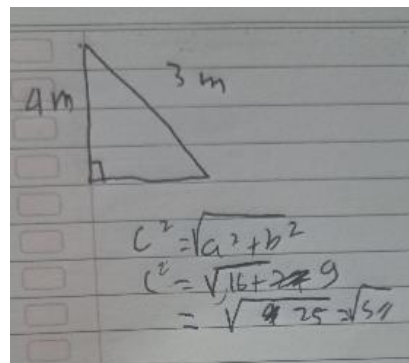
The view regarding the importance of mathematical communication is reinforced by [3] who states that mathematical communication skills have an important role because they help students deepen their understanding, develop more structured thought patterns, and build on their existing mathematical knowledge

To measure this ability, there are three main indicators, namely: (1) writing (*written text*), namely the student's ability to express mathematical ideas and solutions clearly and systematically; (2) drawing (*Drawing*), namely the ability to represent concepts, mathematics into visual forms such as diagrams, graphs, or pictures; and (3) mathematical expression, namely the ability to translate real situations into mathematical symbols, models, and language precisely [4,5,6]. In addition, mathematical communication skills are also related to mathematical representation skills, namely the ability to present ideas in visual, symbolic, or written form to facilitate understanding of concepts [7]. However, in learning practice, students' achievement of mathematical communication skills still faces various obstacles.

The various difficulties experienced by students in conveying mathematical ideas and thought processes indicate that their mathematical communication skills have not developed optimally. In addition, the learning process is still teacher-centered, resulting in limited student participation in learning [8].

Several studies have shown that junior high school students' mathematical communication skills are still relatively low in various school contexts. Students experience difficulties in conveying mathematical ideas both orally and in writing, and are not yet able to optimally fulfill all indicators of mathematical communication [9,10,6]. This condition was also found in students at SMP IT Insan Robbani. Of the 22 students who participated in the learning, most were only able to draw illustrations and write formulas without accompanying explanations of the underlying concepts. Only 7 students provided complete answers with an accurate explanation of the relationship between the three sides, while the other students did not write explanations or only wrote calculations without descriptions.

Fig. 1 shows an example of a student's answer that is able to describe a right-angled triangle situation and write down the calculation steps using the Pythagorean Theorem formula, but has not been



accompanied by a conceptual explanation of the relationship between the sides.

Fig. 1. Example of a student's written answer to a Pythagorean Theorem question

Based on the results of interviews with eighth grade mathematics teachers, it was found that learning is still dominated by the use of PowerPoint as a medium for delivering material because it is considered practical and easy to use. In addition, the use of static PowerPoint makes learning limited and less varied, so that students tend not to be able to represent mathematical ideas and concepts optimally [11]. This finding is in line with [12] which states that PowerPoint is often used only as a presentation medium without actively involving students, which can have an impact on decreasing student concentration and interest in learning.

The learning conditions that are still limited to the use of PowerPoint indicate the need for more dynamic and interactive learning media to provide meaningful learning variations. Technology-based and visual media are considered capable of helping student engagement and helping them visualize and understand mathematical concepts better [13]. In line with this, [14] states that the use of learning media aims to make communication in learning more effective and efficient, so that students can be actively involved in the learning process. This is in line with the multimedia learning theory put forward by Richard E. Mayer, which states that learning will be more effective when students learn through a combination of words and images (*multimedia learning*), and through three main stages, namely *selecting*, *organizing*, and *integrating information* [15]. One of the media with these characteristics is an educational animated video that is audiovisual in nature, and combines elements of images, text, and sound so that it can be used to support the learning process [16]. In line with this, several studies show that technology-based learning media, including educational animated videos, can encourage student participation, self-confidence, and interest in

learning, as well as help present mathematical concepts more clearly through visualization and systematic solution steps [11,17,18].

One form of utilization of educational animated videos that is widely developed is the use of digital platforms that facilitate the media design process, such as Canva. In line with that, [19] stated that Canva was chosen as a learning media design platform because of its ease of use and completeness of graphic elements that can be adjusted to learning needs. The development of Canva-based animated videos as a mathematics learning medium to support students' mathematical communication in understanding the material through systematic and attractive visual presentations [20]. Previous research has examined the use of Canva-based animated videos as learning media, especially in improving students' understanding of mathematical concepts and learning motivation. However, these studies have not specifically developed educational animated videos designed to facilitate students' mathematical communication skills in a structured manner, especially based on indicators such as writing, drawing, and mathematical expressions. Therefore, the novelty of this research lies in the development of Canva-based educational animated videos that include mathematical communication indicators, namely writing, drawing, and mathematical expressions, into learning the Pythagorean Theorem. The aim of this research is to develop Canva-based educational animated video media that is valid and suitable for use in mathematics learning and functions as a supporting medium to facilitate students' mathematical communication.

2. Method

This research is a Research and Development (R&D) research and development which aims to produce learning media in the form of Canva-based educational animated videos on the Pythagorean Theorem material and to test its feasibility and effectiveness in improving the mathematical communication skills of junior high school students. This study uses the ADDIE model (*Analysis, Design, Development, Implementation, Evaluation*), which is systematic and procedural [21].

In the *analysis stage*, a needs analysis was conducted through interviews with teachers and identification of learning problems. The *design stage* included designing the animated video flow, compiling materials, and designing learning media. The *development stage* was carried out by creating Canva-based educational animated video media which was then validated by three expert validators, namely a material expert, a language expert, and a

media expert. Next, the *implementation stage* was carried out on a limited basis with 22 eighth-grade students of SMP IT Insan Robbani using the developed learning media. At this stage, data collection was carried out in the form of pretest and posttest to measure students' mathematical communication skills after using the learning media. The *evaluation stage* is carried out by analyzing the results of expert validation and the results of student pretest and posttest as a basis for assessing the feasibility and effectiveness of learning media.

The data collection technique in this study was carried out using an expert validation sheet and a pretest and posttest for students' mathematical communication skills. The validation sheet was used to assess the appropriateness of the media in terms of content, language, and presentation. The pretest and posttest were used to measure students' mathematical communication skills before and after using the learning media. The assessment on the validation sheet uses a 5-point Likert scale with a score range of 1-5, while The assessment of students' mathematical communication ability test uses an assessment rubric that refers to three aspects, namely writing ability (*written text*), drawing (*drawing*), and mathematical expression (*mathematical expression*) adapted from [22]. Each aspect is assessed based on certain criteria with a score range of 0-4.

Learning outcomes were analyzed using N-Gain. Expert validation data were analyzed using quantitative descriptive techniques by calculating the percentage of validity scores using the following formula:

$$P = \frac{f}{N} \times 100\%$$

Information:

P = Percentage of validity

F = Total score from data collection results

N = Maximum score

The results of the validity percentage calculation are used to determine the validity level of educational animated video media. Media is declared valid if it is in the range of 61% – 80% and very valid if it is in the range of 81% – 100%. Media that obtains a percentage in this range is declared valid and suitable for use as a learning support medium [23].

Furthermore, the improvement in students' mathematical communication skills was analyzed using the N-Gain (Normalized Gain) test to determine the effectiveness of the use of learning media. N-Gain is calculated using the following formula [24]:

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

N-Gain analysis was used in this study as a comparative quantitative analysis technique to

compare students' pretest and posttest results before and after using learning media. The N-Gain test was used because it can show the extent of student improvement relative to the maximum possible score, providing a more objective way to assess learning effectiveness.

The N-Gain criteria are used to determine the level of improvement in students' mathematical communication skills based on Hake's (1999) interpretation, namely: $g \geq 0.70$ (high), $0.30 \leq g < 0.70$ (moderate), and $g < 0.30$ (low) [25].

3. Results and Discussion

The development of Canva- based educational animated video media in this study was carried out through the ADDIE model stages which include analysis, design, development, implementation, and evaluation.

In the analysis stage, the results of the identification of learning needs in class VIII of SMP IT Insan Robbani showed that students' mathematical communication skills have not yet developed optimally, especially in explaining ideas in writing. Students tend to only draw and write formulas without accompanying explanations, so learning media are needed that can help students express mathematical ideas more clearly and structured.

The design stage involved developing a Canva-based animated educational video media plan tailored to the Pythagorean Theorem and mathematical communication skill indicators. This stage included the presentation flow, visual displays, animation, narration, and contextual problem examples that encouraged students to draw, write formulas, explain the relationships between the sides of triangles, and draw conclusions. The media design ensured a systematic presentation and ease of understanding for students.

The development stage is carried out by realizing the design into an educational animated video media product based on Canva. The media that has been developed is then validated by material experts, language experts, and media experts, namely Mrs. Ratih Handayani, S.Pd., M.Pd. as a mathematics material expert, Mr. Sumarno, M.Pd. as a language expert, and Mr. Hartono, MTI as a media expert, who is a lecturer at Muhammadiyah University Kotabumi. The validation process uses a validation sheet with an assessment covering aspects of content feasibility, language, presentation, and media appearance. Details of the maximum score for each assessment aspect are presented in the following Table 1. For Canva-based

educational animations are presented in the following Table 2.

Table 1

Maximum score of validation research

Assessment Aspects	Number of Grains	Maximum Score Per Item	Maximum Score
Material	12	5	60
Language	12	5	60
Media	12	5	60
Total	36		180

Table 2

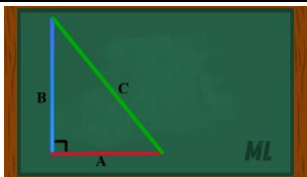
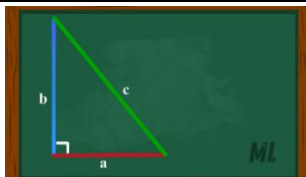
Validation results of Canva-based educational animated video media

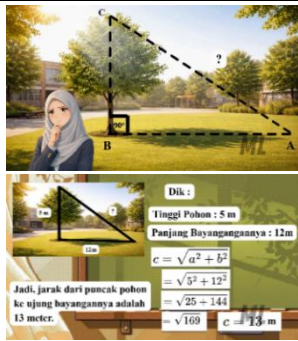
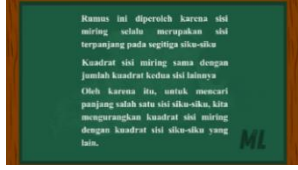
Assessment Aspects	Score	Percentage	Category
Material	53	88.33%	Very Valid
Language	54	90%	Very Valid
Media	53	88.33%	Very Valid
Total Percentage		88.89%	Very Valid

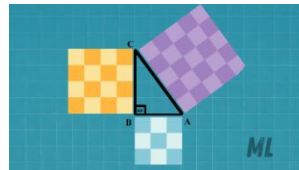
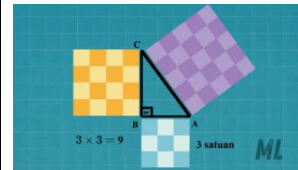
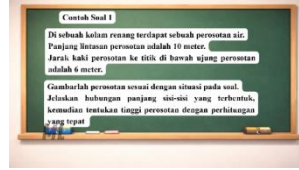
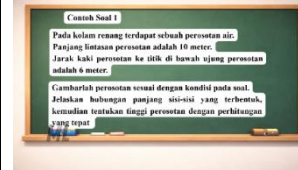
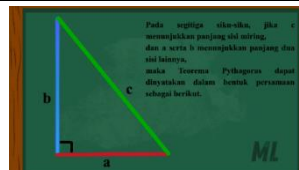
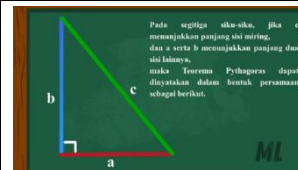
Based on the results of expert validation, educational animated video media obtained a validity percentage of 88.89% with a very valid category so that the developed media was declared suitable for use in learning. These results indicate that the media has fulfilled the aspects of content, language, and display feasibility. This finding is supported by research [26] which states that animated media is able to visualize difficult-to-understand concepts in a form that is easier for students to digest, through the use of elements of movement, color, and sound, animation can bring learning materials to life, animation is able to help convey material more clearly and interestingly for students. To ensure the quality of the developed media is increasingly optimal, the validation process by material experts, language experts, and media experts also produced various comments and suggestions that were used as a basis for improving the media. A summary of these comments and suggestions is presented in the following table.

Table 3

Comments, suggestions, and results of improvements to Canva-based educational animated video media

Comments and Suggestions	Improvement Results
 Before the correction, the writing of the sides of a	 After the correction, the writing of the sides of the

Comments and Suggestions	Improvement Results
triangle still used capital letters which did not comply with mathematical rules.	triangle was changed to lowercase letters to comply with mathematical rules.
 Before the revision, the presentation of the material was still in the form of a re-understanding of the Pythagorean Theorem and needed to be replaced with affirmative sentences.	 After revision, the material was changed into affirmative sentences to clarify the core of the Pythagorean theorem.
Before repair, it is recommended that the video presents the problem at the beginning and the solution at the end.	 After the fix, the problem was added at the beginning of the video and the solution at the end.
Before the fix, the video did not provide information regarding the history or meaning of the Pythagorean Theorem.	 After the revision, an explanation was added regarding the history and meaning of the Pythagorean Theorem.
Before improvements, it is necessary to provide additional explanation regarding the use of the Pythagorean Theorem formula.	 After the fix, an additional explanation was added regarding the use of the Pythagorean Theorem formula.

Comments and Suggestions	Improvement Results
 Before the correction, the presentation was not equipped with calculation information for each square.	 After the fix, calculation information was added to each square.
 Before the correction, the use of the words "in a" and "situation" needs to be corrected.	 After the revision, the use of the words was changed to "on" and "condition".
 Before the fix, the text color composition lacked contrast with the background.	 After the fix, the text color was changed to white to contrast better with the background.

After improvements were made based on comments and suggestions, the media was declared valid and suitable for use. These improvements demonstrated improvements in content, language, and presentation, resulting in optimal quality.

Implementation stage (*Implementation*) was carried out on a limited basis using educational animated video media in mathematics learning in class VIII of SMP IT Insan Robbani.

Table 4

Average Results of Pretest, Posttest, and N-Gain

No	Component	Average	Information
1	Pretest	37.27	
2	Posttest	69.09	
3	N-Gain	0.51	Moderate Increase

The average pretest score of 37.27 increased to 69.09 in the posttest after using the learning media. Furthermore, the average N-Gain score of 0.51 fell into the moderate category, indicating an improvement in student performance after the treatment.

These results indicate that Canva-based educational animated video learning media provides a positive contribution in improving students' mathematical communication skills in the

Pythagorean Theorem material. This is also supported by the ongoing learning process, where students utilize the media as a means to understand concepts more concretely through visualization. During learning activities, students are directed to observe illustrations, understand concepts through visual displays, and solve problems presented in the media. Based on the observation results, students showed active involvement, such as drawing illustrations of right-angled triangles, writing the Pythagorean Theorem formula, and compiling explanations and conclusions regarding the relationship between the sides of right-angled triangles. These findings are in line with quantitative data showing an increase in student learning outcomes. Furthermore, based on further analysis of mathematical communication ability indicators, the average student ability in the writing indicator was 52.27, drawing 74.95, and mathematical expression 84.82. Differences in scores on each indicator indicate variations in students' mathematical communication abilities. These results indicate that students are able to convey mathematical ideas through various forms of representation, both written, visual, and symbolic after using the learning media. The use of Canva-based educational animated video media supports students in expressing mathematical ideas through visual and verbal representations. In line with research [27-32] which states that in mathematics learning, complex concepts can be understood more clearly through visual representation and verbal explanations in videos. To support this finding, examples of student work using Canva-based educational animated video learning media are presented [33-40].

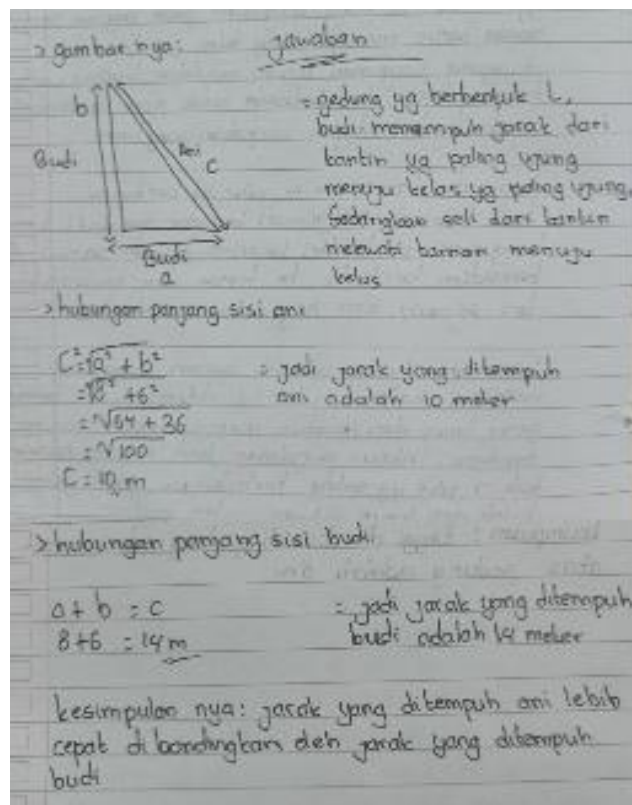


Fig. 2. Example of student answers after learning using Canva-based educational animated videos.

This example shows that students are able to describe problem situations, write calculation steps, and convey written explanations after using Canva-based animated video learning media. Evaluation stage (*Evaluation*) This was conducted by analyzing the expert validation results, as well as the student pretest and posttest results, as a basis for assessing the feasibility and effectiveness of the learning media. The expert validation results showed that the Canva-based educational animated video media achieved a validity percentage of 88.89%, categorized as very valid, indicating that the media met the aspects of content, language, and display feasibility, making it suitable for use as a mathematics learning medium in the classroom [41-45].

Next, the effectiveness of the learning media was analyzed based on the N-Gain results from students' pretest and posttest data. The analysis showed an N-Gain value of 0.51, which is considered moderate. This value indicates an improvement in students' mathematical communication skills after using the learning media. This improvement can be seen in students' ability to describe problems, write down steps for solving them, and convey explanations and conclusions more systematically.

Thus, the evaluation results show that the media developed not only meets the feasibility aspects based on expert validation, but also provides a positive contribution in improving students' mathematical communication skills [46-48].

4. Conclusion

Based on the results of research and development, Canva-based educational animated video media on the Pythagorean Theorem material developed with the ADDIE model was declared suitable for use in mathematics learning based on expert validation results with a validity percentage of 88.89% which is included in the very valid category. In addition, the analysis results showed an average N-Gain value of 0.51 which is included in the moderate category, which indicates an increase in students' mathematical communication skills after using the learning media. The results of learning observations also support these findings, where students showed involvement in drawing, writing down solution steps, and compiling mathematical explanations and conclusions more systematically. The novelty of this research lies in the development of a Canva-based educational animated video that integrates mathematical communication skills indicators writing, drawing, and mathematical expression into learning in a systematic and contextual manner. This research is expected to contribute to alternative learning media that support the development of students' mathematical communication skills. This research still has limitations, such as the relatively limited sample size and small-scale implementation. Therefore, further research is recommended to involve a larger sample size, use a more robust research design, and develop and test learning media on other mathematics materials to obtain more comprehensive results.

CRedit authorship contribution statement

Marniati Laksono: Conceptualization, methodology, Data Collection, Formal Analysing, Writing – original draf. Venty Meilasari: Supervision, Validation, Weiting – review & editing.

Declaration of Competing Interest

The authors declare that this study did not involve any conflicts of interest that could potentially influence the research process, data analysis, presentation of results, or preparation of the article.

Data availability

The data supporting the findings of this study were obtained from 500 articles published between 2017 and 2026.

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