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Development of Mathematical Comic to Improve Student Learning Achievement

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ABSTRACT

This research aims to develop mathematics comic learning media that is valid, practical, and effective in improving student learning outcomes. The research background is based on problems in mathematics learning, where abstract concepts are often difficult for students to understand. Mathematics comics, as a visual medium that combines narrative and illustration elements, have the potential to present mathematical concepts in a more-interesting and easy to understand manner, thereby increasing student motivation and learning outcomes. This research uses the development research (R&D) method with the ADDIE (Analysis, Design, Development, Implementation and Evaluation) development model. The research was carried out at Bustanul Hikmah Islamic Vocational School, involving class XI students as test subjects. Data collection instruments include expert validation questionnaires, student response questionnaires, and learning outcomes tests. The results of expert validation show that the mathematics comic developed meets valid criteria in terms of content, construction and language. The results of the practicality trial show that the mathematics comic is easy to use, the material is presented clearly, and attracts students' interest. Analysis of learning outcome data shows a significant improvement after using mathematics comics. Thus, it can be concluded that the mathematics comics developed are valid, practical and effective for improving student learning outcomes. This mathematics comic can be an innovative and interesting alternative learning media to improve the quality of mathematics learning.

Keywords: *Mathematics Comics, Learning Media, Learning Achievement*

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INTRODUCTION

Mathematics is a subject that is often considered difficult by many students at school. Mathematics is also considered a complicated subject to learn (Khardita et al., 2023; Lestari et al., 2024). This can be caused by various factors, such as negative perceptions of mathematics lessons, difficulties in understanding abstract concepts, and lack of motivation in learning (Khairullah & Heriyana, 2023; Rizkyta

& Astriani, 2024; Siregar et al., 2024). Various efforts have been made to improve student learning outcomes in mathematics. Efforts that can be made to improve student learning outcomes are by using interactive learning models or by using interesting learning media (Prianggono et al., 2023). Educators can create learning tools or media to make learning easier for students so that they can improve learning outcomes (Sugianto et al., 2023). One of the interesting and interactive learning media that can be used is mathematics comics (Nafala, 2022).

Mathematics comics are a form of learning media that can help students understand mathematical concepts in a way that is more fun and easy to understand (Kurniawarsih & Rusmana, 2020). Comics can present mathematical material in the form of stories equipped with interesting pictures, so that students can learn while playing (Febriyandani, 2021). According to Gumilang et al. (2019) Comics are effective in improving student learning outcomes, especially those related to problem solving. Apart from that, the use of mathematics comics can also help increase students' learning motivation. Motivated students tend to be more active and enthusiastic in participating in learning, so that they can increase their understanding of the subject matter (Prianggono et al., 2023; Tambunan et al., 2022). This is in line with the results of research by Nafala (2022) which states that comic media is useful in increasing students' learning motivation.

Several studies show that the application of mathematics comics can improve student learning outcomes. Based on research conducted by (Syahwela, 2020)which shows that learning mathematics using comics can increase students' learning motivation so that it has a positive impact on improving students' mathematics learning outcomes. Research also conducted by (Anisa et al., 2023) stated that the comic media used was declared effective with the completion of the learning achievement test being 95% with the class average score being 84.5. Mathematics comics are effective for improving students' literacy skills (Rakasiwi et al., 2019). Comic media can improve students' numeracy skills (Rahim et al., 2022). Apart from that, mathematics comics also improve student learning outcomes in quadratic equations (Peni et al., 2024)

Students also showed positive responses after learning using comic media. Most students responded well, even very well, to the use of mathematics comics (Syahwela, 2020). According to Nafala (2022), comic media is able to encourage students to grow their interest in learning. The application of comics in mathematics learning, especially at the elementary school level, has proven effective in improving student learning outcomes. This makes the author want to research the application of mathematics comics to high school level students.

METHOD

This research, which aims to determine the effectiveness of applying mathematics comic media to the learning outcomes of high school students, is a type of research and development (R&D). Development research or Research and Development (R&D) is a type of research that aims to develop valid and practical

products that are used in the learning process (Sugiyono, 2021). The product designed in this research is comics as a mathematics learning medium on integral material. Researchers use a development model with the ADDIE approach with stages of Analysis, Design, Development, Implementation, and Evaluation.

Figure 1 Chart of the ADDIE Development Model

The subjects in this research were class XI of Bustabul Hikmah Islamic Vocational School with a total of 28 students. The data collection instruments used were questionnaires and test questions. Questionnaires were given to validators, namely media experts, material/content experts, learning experts/class teachers, and class XI students. The test was given to class students who were used as research subjects.

The data analysis technique used by researchers is using a quantitative approach where this approach is used to measure student learning outcomes which include pretest and posttest and measure product validation which includes media validation by media expert validators, and material validation by learning experts/subject teachers

RESULTS AND DISCUSSION

Results

This research produces a product in the form of an integral mathematics comic which was developed based on the ADDIE stages. By using the ADDIE model, the stages of comic development can be carried out systematically and structured, so as to produce comic products that are effective as a mathematics learning medium that is interesting and easy for students to understand. The stages in development are described as follows.

1. Analysis

The first stage carried out is analysis. Researchers conducted an analysis of students' needs through observing learning activities in class which focused on compulsory mathematics learning. The results of the analysis show that: 1) the curriculum used is an independent curriculum, 2) the teaching materials used by teachers consist of student and teacher handbooks published by the Ministry of

Education and Culture, 3) teachers have not used teaching media that can increase student learning motivation. So it is necessary to innovate the learning process, by developing teaching media that can help implement learning. One media that can be developed is mathematics comics, because comic media can increase students' learning motivation (Nafala, 2022). The selection of comics was also based on the results of interviews with students who wanted interesting learning media in the form of stories accompanied by pictures. Mathematics comic media is very interesting when used in the learning process (Putra & Milenia, 2021).

2. Desain

The second stage carried out in developing comic media is design. Design is a very important part in the development of this media, because with an attractive design, students will be enthusiastic about reading the comic. The media was designed using Corel Draw to create integral mathematical comic visualizations. The Integral Mathematics Comic contains mathematics lesson material in the integral chapter which is packaged with a simple story in it. Comic creation begins with creating a cover page that contains the title of the comic and displays the characters that will appear in the story. The cover page is designed to be as attractive as possible to influence students' attention in reading.

Researchers design storylines that are relevant to integral material by using stories that relate to integral applications in real life. Researchers Design illustrations and characters that support an integral understanding of the material, and consider the use of color, typography and other visual elements to increase attractiveness. Then develop integral concepts that will be explained through comics, in language that is easy for students to understand.

3. Development

a. Comic Creation

This stage is the stage of making comics based on the designs that have been created. The first page contains the comic cover. The cover design can be seen in Figure 2.

Figure 2 Comic Cover

The second page and so on start to include the material you want to convey. The material contained in the comic is a summary of the concepts that will be studied in the integral chapter.

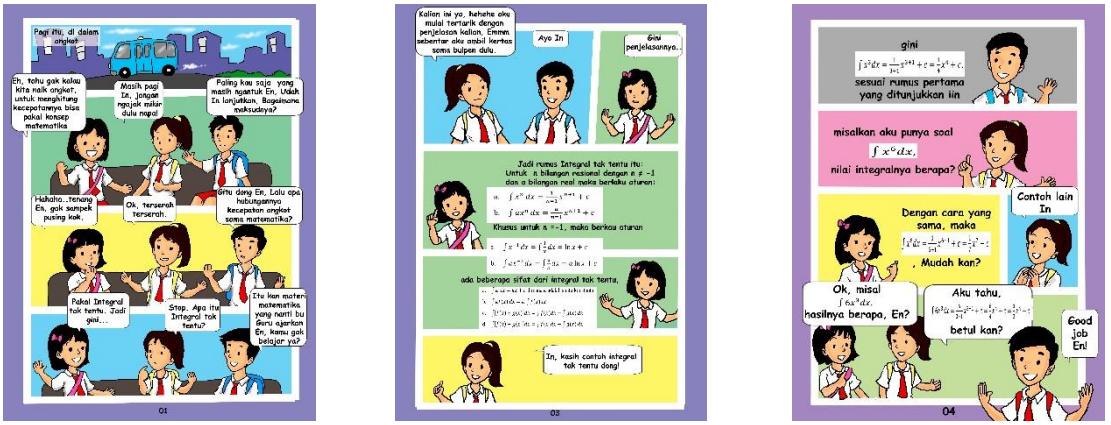

Figure 3 Learning Materials in Comics

b. Validation of Learning Media

The comics that have been developed are then validated by 2 validators who are mathematics subject teachers at Bustanul Hikmah Islamic Vocational School. Validation is carried out to determine the suitability of the material and comic media being developed.

c. Product Revision

Product revisions are carried out when receiving suggestions from the two validators. Suggestions from one of the validators stated that it was necessary to write down the learning objectives that would be implemented.

4. Implementation

At this stage, the effectiveness of the comic learning media was tested. Effectiveness testing is carried out by giving pretests and posttests to students. Students are first asked to do a pretest, then given comics to study. After that, they did the posttest. The results of the pretest and posttest are used to assess students' understanding of integral material and to measure the effectiveness of the Integral Mathematics Comic learning media that has been developed.

5. Evaluation

The evaluation stage was carried out to analyze data on validity, practicality and to analyze data on the effectiveness of the Integral Mathematics Comic learning media.

a. Validity

Analysis of the validation data that has been obtained to see the suitability of the material and media for Integral Mathematics Comics. The validity test results are written in Table 1.

Table 1. Validity Test Results

No	Aspect	Average Score	Category
1.	Curriculum Conformity	4.33	Valid
2.	Depth of Material	4.00	Fairly Valid
3.	Clarity of Material	4.33	Valid
4.	Comic Logic Flow	4.33	Valid

5.	Illustration	3.67	Fairly Valid
6.	Text Readability	4.33	Valid
7.	Language Accuracy	4.67	Valid
8.	Ease of Understanding	4.33	Valid
Average		4.25	Valid

Based on the table above, it is known that the comic being developed meets the valid criteria. Validation is seen from three main aspects, namely material, design and language used. The average validation value of 4.25 is in the valid category. The material aspect consists of criteria for curriculum suitability, depth of material, and clarity of material.

b. Practicality

The practicality test helps validate whether the learning media is feasible to be implemented on a wider scale. If the media is proven to be practical, useful and interesting for students and teachers, then the media can be recommended for use in mathematics learning. The results of the practicality test for integral mathematics comic media are written in Table 2.

Table 2. Practicality Test Results

No	Aspect	Average Score	Category
1.	Ease of Use	4.43	Practical
2.	Clarity of Material	4.5	Practical
3.	Attractiveness	4.46	Practical
4.	Expediency	4.6	Practical
Average		4.5	Practical

Based on student response questionnaire data and the results of observations of student activities, it can be concluded that Integral Mathematics Comics meets practical criteria. Students gave positive responses to the ease of use, clarity of material, attractiveness and usefulness of comics. Observations show that students are active and enthusiastic in using comics as a learning medium.

c. Effectiveness

This test aims to measure the effectiveness of the Integral Mathematics Comic by comparing student learning outcomes before (pretest) and after (posttest) using the comic. Analysis using Paired Sample t-test was carried out to see the significance of the average difference between pretest and posttest scores. Before carrying out a hypothesis, a prerequisite test is carried out consisting of a test for normality and homogeneity of the data. The prerequisite test results stated that the pretest and posttest data met the normal and homogeneous requirements.

The first hypothesis test is to find out whether the average student learning score exceeds the criteria for achieving learning objectives (reaches the KKTP, namely $\mu_0 = 75$). The test uses a one-party average test, namely the left side, with H_0 and H_1 as follows.

- $H_0: \mu_1 \leq 75$ (average student learning outcomes less than equal to 75)
- $H_1: \mu_1 > 75$ (average student learning outcomes more than 75)

Based on the calculation results above, the t_{count} value is 3.62 and $t_{tabel} =$ 1.703 with a significance level of $\alpha = 5\%$, so that $t_{count} > t_{tabel}$, then the decision is to reject H_0. It can be concluded that the average student learning outcomes after carrying out learning using Integral Mathematics Comics exceed the criteria for achieving learning objectives (KKTP).

The second hypothesis test is to determine the increase in student learning outcomes through this test using the Paired sample T-test. The hypothesis consists of H_0 and H_1 as follows.

- $H_0: \mu_1 \leq \mu_2$ (the average student learning outcomes did not increase)
- $H_1: \mu_1 > \mu_2$ (the average student learning outcomes increased)

Hypothesis testing uses a significance level of 5% ($\alpha = 0.05$) with test criteria, namely reject H_0 if $t_{count} \geq t_{table}$.

Table 3 Paired Sample t-Test output

Paired Samples Test

		Paired Differences					t	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	post_test - pre_test	60,5859	12,97091	2,29295	55,90943	65,26245	26,423	31	,000

Based on the paired sample T-test with the help of SPSS, the value of $t_{count} =$ 26.423, while the value of $t_{table} =$ 1.696, because the value of $t_{count} \geq t_{tabel}$ then the decision that can be taken is that H_0 is rejected. It was concluded that the average value of learning outcomes for students who studied using Integral Mathematics Comics had increased compared to before.

Discussion

Based on the results of data analysis, it is known that the comics developed are effective in improving student learning outcomes. The effectiveness of mathematics comic learning media in improving student learning outcomes has been supported by various studies, showing significant increases in student engagement and understanding of mathematical concepts. Development of effective mathematics comics as a learning medium (Febriyandani, 2021; Putro & Setyadi, 2022; Syahwela, 2020). The integration of comics into mathematics education not only makes learning fun but also facilitates better understanding and retention of the material. The use of comic media in mathematics learning resulted in a significant increase in problem solving abilities, with experimental class students achieving an average score of 72.50 compared to 60.31 in the control class (Firmansyah et al., 2024). Research on interactive mathematics comics reveals that they show increased student motivation and interest in learning (Marhaeni et al., 2025; Yulanda et al., 2022). Fitriyani et al.

(2021)stated that the application of comic media can improve students' mathematical literacy skills better or be superior in understanding story problems on cubes and blocks.

Mathematics comics also increase students' learning motivation, so that students are more enthusiastic in carrying out learning. This is proven by the positive response from students. According to (Haqiqi & Permadi, 2022), the use of mathematics comics significantly increases students' learning motivation compared to conventional learning. Students show higher enthusiasm in following lessons and doing assignments. Comics can attract students' attention and arouse interest in learning. Strong visual elements such as dynamic illustrations, bright use of color, and creative layout, combine with an engaging storyline, creating a more enjoyable learning experience. Characters in comics, if designed well, can become representations of students themselves or inspiring role models, thus encouraging them to be more involved in learning mathematics. Narratives in comics can provide meaningful context, help students relate mathematical concepts to their own experiences, and make learning more relevant (Firmansyah et al., 2024; Fitriyani et al., 2021).

CONCLUSION

The development of Integral Mathematics Comic Media meets valid and practical criteria. The comic is valid in the aspects of content/material, construction/design, and language, with an overall validation score of 4.25. Its use also received a positive response from students. Comics are effectively used as a learning medium and can improve student learning outcomes in integral material, as seen from the increase in scores during the posttest.

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