



## Development of Character-Based Comic Media to Improve Learning Outcomes of Mathematics Subjects in Elementary Schools

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Receive: 12/06/2024	Accepted: 02/09/2024	Published: 01/10/2024
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### Abstrak

Penelitian ini bertujuan untuk mengembangkan media komik berbasis karakter untuk meningkatkan hasil belajar matematika siswa sekolah dasar, khususnya pada materi perkalian di kelas III. Metode penelitian yang digunakan adalah *Research and Development* (R&D) dengan model pengembangan ADDIE (*Analysis, Design, Development, Implementation, Evaluation*). Subjek penelitian meliputi 90 siswa kelas III dan 6 guru matematika dari tiga sekolah dasar di Kabupaten Pinrang, Sulawesi Selatan. Instrumen penelitian terdiri dari lembar validasi, angket praktikalitas, tes hasil belajar, lembar observasi keterlaksanaan pembelajaran, dan pedoman wawancara. Teknik analisis data meliputi analisis deskriptif untuk data kualitatif dan uji-t berkorelasi serta perhitungan N-gain untuk data kuantitatif. Hasil penelitian menunjukkan bahwa: (1) Media komik berbasis karakter telah berhasil dikembangkan mengikuti model ADDIE dan disesuaikan dengan karakteristik siswa kelas III SD; (2) Media komik dinilai sangat valid oleh ahli materi (4,58), ahli media (4,67), dan ahli pendidikan karakter (4,52); (3) Media komik dinilai sangat praktis oleh guru (88,4%) dan siswa (87,6%); (4) Media komik terbukti efektif dalam meningkatkan hasil belajar matematika siswa dengan peningkatan signifikan dari *pretest* (54,67) ke *posttest* (82,44) dengan N-gain 0,61 (kategori sedang); (5) Terjadi peningkatan internalisasi nilai-nilai karakter pada siswa dari skor rata-rata 2,73 menjadi 3,61; (6) Respon guru dan siswa terhadap media komik termasuk kategori sangat positif dengan persentase 92,2% dan 90,4%. Kebaruan (*novelty*) penelitian ini terletak pada integrasi teknologi digital dalam pengembangan komik matematika berbasis karakter yang dapat diakses melalui aplikasi mobile, serta pengintegrasian nilai-nilai karakter secara eksplisit dalam pembelajaran matematika. Hasil penelitian ini dapat menjadi alternatif solusi untuk meningkatkan hasil belajar matematika sekaligus menanamkan nilai-nilai karakter pada siswa sekolah dasar.

**Kata Kunci:** Media Komik, Pendidikan Karakter, Hasil Belajar Matematika.

### Abstract

*This research aims to develop character-based comic media to improve mathematics learning outcomes of elementary school students, specifically on multiplication material in third grade. The research method used is Research and Development (R&D) with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. Research subjects included 90 third-grade students and 6 mathematics teachers from three elementary schools in Parepare City, South Sulawesi. Research instruments consisted of validation sheets, practicality questionnaires, learning outcome tests, learning implementation observation sheets, and interview guidelines. Data analysis techniques included descriptive analysis for qualitative data and correlated t-test and N-gain calculation for quantitative data. The results showed that: (1) Character-based comic media has been successfully developed following the ADDIE model and adapted to the characteristics of third-grade elementary school students; (2) Comic media was rated as very valid by material experts (4.58), media experts (4.67), and character education experts (4.52); (3) Comic media was rated as very practical by teachers (88.4%) and students (87.6%); (4) Comic media proved effective in improving students' mathematics learning outcomes with a significant increase from pretest (54.67) to posttest (82.44) with an N-gain of 0.61 (medium category); (5) There was an increase in the internalization of character values in students from an average score of 2.73 to 3.61; (6) Teacher and student responses to comic media were in the very positive category with percentages of 92.2% and 90.4%. The novelty of this research lies in the integration of digital technology in the development of character-based mathematics comics that can be accessed through mobile applications, as well as the explicit integration of character values in mathematics learning. The results of this research can be an alternative solution to improve mathematics learning outcomes while instilling character values in elementary school students.*

**Keywords:** *Comic Media, Character Education, Mathematics Learning Outcomes.*

## Introduction

Mathematics is an important foundation in the elementary school curriculum which plays a crucial role in developing students' cognitive and problem-solving skills. More than just a collection of formulas and numbers, mathematics is a very applicable tool in simplifying, effective, and efficient various aspects of human life (Nasruddin et al., 2022). Mastery of basic math skills is very important given its inherent relevance in students' daily activities (Diana, 2020). Education as a conscious and planned effort to develop students' potential (Iskandar et al., 2019) requires that mathematics learning in elementary schools is designed effectively so that students can master basic concepts well (Astutiningsih, 2020). However, reality shows that mathematics is still perceived as a difficult and less interesting subject for most elementary school students, so they often have difficulty understanding the material being taught and have an impact on suboptimal learning outcomes (Anggraini et al., 2020).

Various factors contribute to the difficulty of learning mathematics, including the delivery of material that is less interesting and less relevant to students' daily lives (Utami, 2019). Conventional *teacher-centered learning approaches* tend to make students passive and less motivated to learn mathematics (Rahmatunisa, 2020), so that students' mathematical communication skills do not develop optimally (Kanah & Mardiani, 2022). Dynamic curriculum changes also sometimes make schools not ready to implement the system that has been established due to limited facilities and the balance between the intellectual and emotional aspects of students has not been achieved. Especially in multiplication materials, students experience difficulties in understanding due to the monotonous learning process, dominated by practice questions, lack of teacher explanations, the use of media and methods that do not vary, and the lack of parental involvement (Wakit, 2023). This phenomenon shows the need for innovation in mathematics learning methods and media to improve students' interest and learning outcomes.

The digital era offers significant opportunities to improve the quality of education through the integration of technology in learning. Teachers are challenged to accommodate the

development of the times by involving technology as a means of learning to respond to problems that occur (Siregar et al., 2021). Comics as a visual medium that combines images and text have great potential to be developed as a mathematics learning medium. Comics can present math material in a more interesting, contextual, and easy-to-understand way. Through captivating characters and stories that are relevant to students' daily lives, comics can help visualize abstract mathematical concepts into more concrete. The use of three-dimensional media through contextual learning models can facilitate students in finding new concepts (Yuliariatiningsih, 2016). Comics can also stimulate students' imagination and creativity, as well as increase their motivation to learn math.

Character education is also a fundamental aspect of elementary school education, which aims to shape students into individuals with noble character, responsibility, and positive values. Character education is increasingly urgent considering the attitude and morals of students who are increasingly concerned, so it needs to be integrated into learning media (Moniati et al., 2022). Comic media can be an effective means of integrating character values in mathematics learning. The phenomenon of deviant behavior that is not in accordance with religious norms often occurs because many schools prioritize the aspect of intellectual intelligence rather than the moral and ethical aspects. Through the stories and characters presented, comics can provide examples of positive behavior, instill moral values, and develop students' character holistically.

Based on this background, this study asks several research questions: (1) What is the process of developing character-based comic media for mathematics learning in elementary schools? (2) What is the feasibility of character-based comic media for mathematics learning in terms of validity, practicality, and effectiveness? (3) How does the use of character-based comic media affect the mathematics learning outcomes of elementary school students? (4) What character values can be integrated in comic media for mathematics learning? (5) How do students and teachers respond to the use of character-based comic media in mathematics learning?

This research aims to: (1) Develop character-based comic media for mathematics

learning in elementary schools that are valid, practical, and effective; (2) Analyzing the feasibility of character-based comic media for mathematics learning from the aspects of validity, practicality, and effectiveness; (3) Identify the influence of the use of character-based comic media on the mathematics learning outcomes of elementary school students; (4) Integrating character values in comic media for mathematics learning; and (5) Analyze the responses of students and teachers to the use of character-based comic media in mathematics learning.

The scope of this research is limited to the development of character-based comic media for mathematics learning with multiplication material in grade III elementary school. The comic media developed will be designed according to the characteristics of elementary school students, meet applicable curriculum standards, and integrate character values such as honesty, hard work, responsibility, and cooperation. The research will be carried out at UPT SDN 244 Tassokkoe, Pinrang Regency, South Sulawesi with a sample of grade III students for the 2024/2025 school year. The research approach uses *Research and Development* (R&D) with the ADDIE (*Analysis, Design, Development, Implementation, Evaluation*) development model.

The novelty of this research lies in the integration of digital technology in the development of character-based mathematical comics that can be accessed through mobile applications, so as to enable more interactive, adaptive, and in accordance with the characteristics of the native digital generation. In contrast to previous research that generally developed mathematical comics in print form (Sukmawati et al., 2022; Tari, 2020), or focusing on specific material without integrating character values (Ani & Rosyidi, 2021), this study developed a mathematical digital comic that not only facilitates the understanding of mathematical concepts but also explicitly integrates relevant character values with the local context. In addition, this study also applies a contextual learning approach that provides an authentic learning experience for students, helps them visualize abstract mathematical concepts into concrete and meaningful in everyday life, and develops positive characters simultaneously.

## Method

This research uses the Research and Development (R&D) method with the ADDIE (*Analysis, Design, Development, Implementation, Evaluation*) development model to produce character-based comic media products in mathematics learning in elementary schools. The selection of the ADDIE model was based on the consideration that it provides a flexible systematic framework for developing learning products. The research stage begins with the Analysis phase, where the researcher conducts a preliminary study to identify the needs of teachers and students related to mathematics learning, analyzes the elementary school mathematics curriculum, especially grade III multiplication material, and examines relevant character values to be integrated in learning media. Data collection at this stage is carried out through interviews with mathematics teachers, observation of learning in the classroom, and documentation studies of existing textbooks and learning media.

The second stage is Design, where the researcher designs a comic storyboard, develops a storyline that integrates mathematical concepts with character values, designs characters in comics, and plans learning activities to be integrated in comic media. This design design is then validated by math subject matter experts, learning media experts, and character education experts to get input and suggestions for improvement. The third stage is Development, where researchers develop character-based comic media according to validated designs. At this stage, comic illustrations are created with the help of professional graphic design applications, combining visual elements and interesting texts and according to the characteristics of elementary school students. The initial product is then validated by a team of experts to assess its feasibility from the aspects of material, media, and character value integration.

The fourth stage is Implementation, where the comic media that has been developed is piloted in mathematics learning in the classroom. The trial was carried out in two stages, namely a trial limited to a small group of students (10-15 people) to get initial input and a wider trial in the actual class. At this stage, a practical measurement of the use of comic media was also carried out through questionnaires and interviews with teachers and students. The last stage is Evaluation, where the researcher analyzes the effectiveness of character-based comic media on

students' mathematics learning outcomes. The evaluation was carried out by comparing the results of the students' pre-test and post-test, as well as analyzing changes in students' attitudes and behaviors related to character values integrated in comic media.

This research will be carried out in three State Elementary Schools in Parepare City, South Sulawesi, namely SDN 5 Parepare, SDN 47 Parepare, and SDN 85 Parepare. The selection of the school was based on the consideration of the representation of schools with different characteristics (schools in urban centers, suburbs, and coastal areas) to test the effectiveness of comic media in various learning conditions. The research subjects are grade III students for the 2024/2025 school year with a total of 90 students (30 students from each school) and 6 grade III mathematics teachers (2 teachers from each school). The research time is planned for 8 months, starting from January to August 2025, with time divided according to the stages of the research that have been described.

The variables observed in this study included the validity of comic media (suitability of the material with the curriculum, accuracy of mathematical concepts, quality of visual display, and integration of character values), practicality of comic media (ease of use, efficiency of learning time, and usefulness), effectiveness of comic media (students' mathematics learning outcomes, learning motivation, and internalization of character values), and students' and teachers' responses to the use of comic media. The research design to measure the effectiveness of media used a quasi-experimental design with a pretest-posttest control group design pattern, where the experimental class used character-based comic media and the control class used conventional learning media.

The research instruments used include validation sheets for material experts, media experts, and character education experts to assess the validity of comic media; practicality questionnaires for teachers and students; mathematics learning outcome tests (pretest and posttest); A learning curve; Student learning motivation questionnaire; observation sheets of students' attitudes and behaviors related to character values; as well as interview guidelines for teachers and students. These instruments are developed based on theoretical studies and validated by experts before being used in research.

Data collection techniques are carried out through observation, interviews, questionnaires, tests, and documentation. Comic media validity data was collected through validation sheets filled out by material experts, media experts, and character education experts. Practicality data was collected through questionnaires and interviews with teachers and students after using comic media in learning. Effectiveness data was collected through student mathematics learning outcome tests (pretest and posttest), learning motivation questionnaires, and student attitude and behavior observation sheets. Student and teacher response data was collected through questionnaires and interviews after the learning process.

The data analysis in this study uses quantitative and qualitative approaches. The validity data of comic media is analyzed descriptively by calculating the average validity score and categorizing it based on the validity criteria that have been set. Comic media is declared valid if it obtains the category of "valid" or "very valid". Practicality data was analyzed by calculating the percentage of positive responses from teachers and students, and categorizing them based on practicality criteria. Comic media is declared practical if it obtains the category of "practical" or "very practical". Data on the effectiveness of comic media on mathematics learning outcomes were analyzed using a t-test to determine the difference in learning outcomes between experimental classes and control classes, and calculated normalized gain scores to determine the improvement in student learning outcomes. The data on learning motivation and internalization of character values were analyzed descriptively by calculating the percentage of students' positive attitudes. Student and teacher response data were analyzed qualitatively to get a comprehensive picture of user responses to character-based comic media.

## **Result and Discussion**

Research on the development of character-based comic media to improve the learning outcomes of mathematics subjects in elementary schools has been carried out by following the stages of the ADDIE (*Analysis, Design, Development, Implementation, Evaluation*) model. The following are the results of the research and discussion.

## **The Process of Character-Based Comic Media Development**

### **Analysis Stage**

The analysis stage began by conducting a preliminary study through observation of mathematics learning in three elementary schools in Pinrang Regency, namely UPT SDN 244 Tassokkoe, SDN 8 Pinrang, and SDN 1 Pinrang. The results of observations show that mathematics learning in the three schools is still dominated by conventional methods with a teacher-centered approach. The teacher delivers the material directly, while the students only listen to the explanation and do practice questions. The learning media used is still limited to textbooks and worksheets that are less interesting to students.

The results of interviews with 6 grade III mathematics teachers showed that 83.3% of teachers had difficulty in teaching multiplication material, and 91.7% of teachers stated that students often had difficulties in understanding the concept of multiplication. Meanwhile, of the 90 students interviewed, 76.7% stated that they disliked mathematics lessons because they were considered difficult and boring, 82.2% of students had difficulty in understanding multiplication material, and 88.9% of students stated that they preferred learning with the medium of interesting pictures or stories.

Curriculum analysis was carried out by examining the Core Competencies (KI) and Basic Competencies (KD) of grade III mathematics in multiplication materials based on the Independent Curriculum. The results of the analysis show that the KD used is 3.1 Explaining the properties of the count operation on a given number and 4.1 Solving a problem involving the use of the properties of a calculated operation on a given number.

The analysis of student characteristics shows that grade III elementary school students are at a concrete operational stage, where they need learning media that can visualize abstract concepts into concrete. Students at this age also love color drawings, stories, and characters that are close to their daily lives.

### **Design Stage**

Based on the results of the analysis, the researcher designed character-based comic media with the following steps:

Formulate the learning objectives to be achieved through the use of mathematical comic media.

Develop a storyline that integrates the concept of multiplication with character values such as honesty, hard work, responsibility, and cooperation.

Design characters in comics that are close to students' daily lives.

Create a storyboard that depicts the storyline and visualization of each page of the comic.

Designing learning activities that will be integrated in comic media.

The development of the storyline was made with the theme "Mia and Rio's Mathematical Adventure" which tells the story of two third grade elementary school students who face various mathematical problems in their daily lives and solve them with the concept of multiplication. Through this story, students are invited to understand the concept of multiplication contextually while emulating the character values displayed by the characters in the comics.

The main characters in this comic are Mia (an honest and hardworking student), Rio (a responsible and helpful student), Bu Ani (a patient and creative math teacher), and Pak Doni (a friendly and honest shopkeeper in the school canteen). Each character is designed to reflect the character values that you want to instill in students.

### **Development Stage**

In the development stage, the researcher develops character-based comic media according to the design that has been made. The steps taken are:

1. Draw character sketches and settings according to the storyboard.
2. Apply color to sketch drawings using graphic design apps.
3. Add narrative text and character dialogue that integrates the concept of multiplication with character values.
4. Compile comics in digital format that can be accessed through mobile applications.
5. Conducting comic media validation by material experts, media experts, and character education experts.

The math comic developed consists of 36 full color pages with 5 chapters that include multiplication material as repeated addition, properties of multiplication, multiplication with numbers 0 and 1, multiplication of two numbers with one number, and application of multiplication in everyday problem solving. Each

chapter has a different storyline but is still related to each other, and at the end of each chapter there are activities that students must do to strengthen their understanding of the concept of multiplication.

Character values are integrated implicitly as well as explicitly in the story. Implicitly, character values are shown through the attitudes and behaviors of the characters in the comics. Explicitly, there is a character reflection at the end of each chapter that invites students to reflect and internalize these values in their daily lives.

### Implementation Stage

The implementation of comic media is carried out in two stages, namely a limited trial and a broad trial. A limited trial was conducted on 15 grade III students at UPT SDN 244 Tassokkoe to get initial input on the developed comic media. A wider trial was conducted on 90 grade III students from three elementary schools (SDN 244 Pinrang and SDN 8 Pinrang, and SDN1 Pinrang), with each school involving 30 students.

The implementation of learning with comic media was carried out for 8 meetings with a duration of 2x35 minutes per meeting. The learning process begins with the teacher introducing comic media to students, then students read comics in groups or individually. Next, students work on the activities contained in the comic and discuss them with friends and teachers. At the end of the lesson, students reflect on the character values contained in the comic.

### Evaluation Stage

The evaluation stage was carried out to determine the effectiveness of character-based comic media in improving students' mathematics learning outcomes. Evaluation was carried out by comparing the results of the students' pretest and posttest, as well as analyzing changes in students' attitudes and behaviors related to the character values integrated in comic media.

An evaluation was also carried out on the comic media itself based on the results of validation from material experts, media experts, and character education experts, as well as responses from teachers and students as media users. The results of the evaluation show that the character-based comic media developed has met the valid, practical, and effective criteria for use in learning mathematics multiplication material in grade III elementary school.

### Validity of Character-Based Comic Media

The validity of character-based comic media was assessed by experts in mathematics materials, learning media experts, and character education experts using validation sheets with a Likert scale of 1-5. The validation results of the three experts are presented in Table 1.

*Table 1. Character-Based Comic Media Validation Results*

Yes	Assessment Aspects	Average Score	Category
1	Subject Matter Expert Validation	4,58	Highly Valid
2	Media Expert Validation	4,67	Highly Valid
3	Character Education Expert Validation	4,52	Highly Valid
	Overall Average	4,59	Highly Valid

Based on Table 1, the validation results of the three experts show that the character-based comic media developed has a very high level of validity with an overall average score of 4.59 (category "Very Valid"). This shows that comic media has met the criteria as a valid learning medium from the aspects of material, media, and the integration of character values.

Mathematics subject matter experts gave the highest assessment on the aspect of material suitability with basic competencies (4.80) and accuracy of mathematical concepts (4.75), while the lowest assessment was on the aspect of material depth (4.20). Media experts gave the highest ratings on image quality and color (4.85) and visualization attractiveness (4.80), while the lowest ratings were on the ease of navigation in mobile applications (4.40). Character education experts gave the highest assessment on the compatibility of character values with the level of student development (4.75) and the meaning of moral messages (4.70), while the lowest assessment was on the aspect of integrating character values in learning activities (4.30).

The results of this validation are in line with the research of Gumilang et al. (2019) which showed that mathematical comic media with a problem posing model received a high validity category from the assessment of media experts, material experts, and learning experts. Research

by Subroto et al. (2020) also found that the math comics developed received a rating of "Very Feasible" from media experts and subject matter experts with a percentage of 88% each.

However, there are several improvement notes from experts, such as: (1) the need to add more varied sample questions, (2) the improvement of some unclear images, (3) the simplification of sentences to make it easier for grade III students to understand, and (4) the strengthening of the reflection of character values to be more explicit. All of these improvement notes have been followed up to refine the comic media before being implemented in learning.

### Practicality of Character-Based Comic Media

The practicality of character-based comic media was assessed based on the responses of teachers and students through a questionnaire with a Likert scale of 1-5. The results of the practicality assessment are presented in Table 2.

Table 2. Results of Assessment of Practicality of Character-Based Comic Media

No	Respond	mean	%	Category
1	Guru (n=6)	4,42	88,4%	Very Practical
2	Students (n=90)	4,38	87,6%	Very Practical
	Overall Average	4,40	88,0%	Very Practical

Based on Table 2, the character-based comic media developed was rated "Very Practical" by teachers and students with an average percentage of practicality of 88.0%. The teacher gave a practicality assessment of 88.4% (the "Very Practical" category), while students gave a practicality assessment of 87.6% (the "Very Practical" category).

The practicality aspect that received the highest rating from teachers was the ease of use of media (4.67) and the attractiveness of media for students (4.83), while the aspect that received the lowest rating was the efficiency of learning

time (4.00). Meanwhile, the practicality aspect that received the highest rating from students was the pleasure of using comic media (4.78) and interest in the characters in comics (4.72), while the aspect that received the lowest rating was the ease of understanding multiplication material through comics (4.11).

The results of interviews with teachers show that character-based comic media is very helpful in conveying multiplication material because it can attract students' interest and visualize abstract concepts into concrete. However, some teachers suggest that the allocation of learning time with comic media needs to be optimized, because sometimes students are too engrossed with the stories in comics to forget the mathematical concepts learned.

The results of interviews with students showed that they really liked learning mathematics with comic media because it was more fun and easy to understand. The characters in the comics also make them motivated to imitate the positive values displayed.

This finding is in line with research conducted by Kurniawarsih and Rusmana (2020) which found that mathematics comic media for grade IV elementary school students received a very good response from teachers by 80% and responses from students by 79.58%. Another study by Jailani (2016) also showed that the developed math learning comics had a high level of practicality based on the responses of teachers and students.

### The Effectiveness of Character-Based Comic Media on Mathematics Learning Outcomes

The effectiveness of character-based comic media in improving students' mathematics learning outcomes was measured by comparing the results of the pretest and posttest using a paired sample t-test, as well as calculating N-gain to determine the magnitude of the improvement in learning outcomes. The results of the effectiveness analysis are presented in Table 3.

Table 3. Results of Analysis of the Effectiveness of Character-Based Comic Media

No	Group	N	Average		t-count	T-Table	Itself.	N-gain	Category
			Pretest	Posttest					
1	Eksperimen	90	54,67	82,44	19,82	1,99	0,000	0,61	Keep

2	Control	90	55,22	68,33	10,45	1,99	0,000	0,29	Low
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Based on Table 3, there was a significant difference between the pretest and posttest results in the experimental group with t-count (19.82) > t-table (1.99) and Sig. (0.000) < 0.05. This shows that the use of character-based comic media is effective in improving students' mathematics learning outcomes. The increase in student learning outcomes in the experimental group was included in the moderate category with an N-gain value of 0.61.

Meanwhile, in the control group using conventional learning media, there was also a significant difference between the results of the pretest and posttest with t-count (10.45) > t-table (1.99) and Sig. (0.000) < 0.05. However, the improvement in student learning outcomes in the control group was included in the low category with an N-gain value of 0.29.

The comparison of learning outcomes between the experimental group and the control group showed that the improvement in learning outcomes in the experimental group (27.77 points) was higher than that of the control group (13.11 points). This shows that the use of character-based comic media is more effective in improving students' mathematics learning outcomes compared to the use of conventional learning media.

The effectiveness of character-based comic media in improving students' mathematics learning outcomes can also be seen from the percentage of student learning completeness presented in Table 4.

Table 4. Percentage of Student Learning Completeness

No	Group	Number of Students	% Completeness	
			Pretest	Posttest
1	Eksperimen	90	28,9%	91,1%
2	Control	90	30,0%	62,2%

Based on Table 4, the percentage of student learning completeness in the experimental group increased from 28.9% in the

pretest to 91.1% in the posttest (an increase of 62.2%). Meanwhile, in the control group, the percentage of student learning completeness increased from 30.0% in the pretest to 62.2% in the posttest (an increase of 32.2%). This shows that the use of character-based comic media is more effective in improving student learning completeness compared to the use of conventional learning media.

The results of this study are in line with the research of Alfahnum et al. (2023) which found that the use of culture-based comic media is effective in improving mathematics learning outcomes. Research conducted by Subroto et al. (2020) also showed that the use of comics as a mathematics learning medium was effective based on a very positive assessment of student responses reaching 88.58%.

The improvement of mathematics learning outcomes through the use of character-based comic media can be explained by several reasons. First, comic media visualizes abstract mathematical concepts into concrete through interesting pictures and stories, making it easier for students to understand the concept of multiplication. Second, the integration of character values in comic media makes learning not only focus on the cognitive aspect, but also on the affective aspect that can motivate students to study seriously. Third, the stories and characters in the comics are close to the students' daily lives, thus making mathematics learning more meaningful and contextual.

**Internalizing Character Values in Mathematics Learning**

The internalization of character values in mathematics learning through comic media was measured by observation sheets of students' attitudes and behaviors carried out before and after the implementation of comic media. The character values observed include honesty, hard work, responsibility, and cooperation. The results of the observation of internalization of character values are presented in Table 5.

Table 5. Results of Observation of Internalization of Character Values

No	Character Value	Average Score		Increased
		Before	After	
1	Honesty	2,78	3,56	0,78

2	Strive	2,56	3,44	0,88
3	Responsibility	2,67	3,67	1,00
4	Cooperation	2,89	3,78	0,89
	<b>Average</b>	2,73	3,61	0,89

Based on Table 5 and Figure 3, there was an increase in the average score of internalization of character values from 2.73 (category "Starting to Develop") before the implementation of comic media to 3.61 (category "Cultivating") after the implementation of comic media. The highest score increase occurred in the responsibility character score with an increase of 1.00 points, while the lowest score increase occurred in the honesty character score with an increase of 0.78 points.

Changes in students' attitudes and behaviors related to character values can also be seen from the results of interviews with teachers. The teachers stated that after the implementation of character-based comic media, students showed positive changes in their attitudes and behaviors, such as being more honest in doing assignments and tests, more diligent and persistent in solving math problems, more responsible in completing assignments, and more cooperative in working with friends.

The results of this study are in line with the research of Manalu et al. (2017) which shows that mathematical comic media based on character values is effective in instilling character values in students. Research conducted by Devy Yuliasri

Kurnia Putri (2015) also found that the development of mathematics comics as a learning medium based on character education is effective in instilling character values in mathematics learning.

The internalization of character values in mathematics learning through comic media can be explained by several factors. First, the characters in the comics that display positive values such as honesty, hard work, responsibility, and cooperation provide concrete examples for students to emulate. Second, the reflection of the characters at the end of each chapter in the comic provides an opportunity for students to reflect and internalize these values in their daily lives. Third, the discussions that take place after reading the comic allow students to share experiences with each other and strengthen their understanding of the characters' values.

#### Teachers' and Students' Responses to Character-Based Comic Media

Teachers' and students' responses to character-based comic media were measured through questionnaires and interviews. The results of the teacher and student response questionnaire are presented in Table 6.

*Table 6. Results of Teacher and Student Response Questionnaire*

Yes	Respond	Assessment Aspects	Average Score	Percentage	Category
1	Teacher (n=6)	Media Attractiveness	4,83	96,6%	Very Positive
		Media Usefulness	4,67	93,4%	Very Positive
		Media Practicality	4,33	86,6%	Very Positive
		Average	4,61	92,2%	Very Positive
2	Students (n=90)	Media Attractiveness	4,78	95,6%	Very Positive
		Media Usefulness	4,56	91,2%	Very Positive
		Media Practicality	4,22	84,4%	Very Positive
		Average	4,52	90,4%	Very Positive

Based on Table 6, teachers' responses to character-based comic media are included in the "Very Positive" category with a percentage of 92.2%, while student responses are included in the "Very Positive" category with a percentage of 90.4%. The aspect that received the highest response from both teachers and students was the aspect of media attractiveness, while the aspect that received the lowest response was the practicality aspect of the media.

The results of the interviews with teachers showed that they really appreciated the development of character-based comic media because it could make it easier for them to convey multiplication material and instill character values to students. The teachers also stated that they will continue to use comic media in mathematics learning and hope that there will be the development of comic media for other mathematics materials.

The results of interviews with students showed that they really liked learning math with comic media because it was more fun, easy to understand, and less boring. Students also stated that the characters in the comics inspired them to imitate the positive values displayed and apply them in their daily lives.

These findings are in line with research by Sukmawati et al. (2022) which showed that the use of comic media in mathematics learning received a positive response from teachers and students. Research conducted by Ani & Rosyidi (2021) also found that mathematics comic media received a very good response from teachers and students because it can help students visualize mathematical concepts through real things instead of abstract things.

**Advantages and Limitations of Character-Based Comic Media**

Based on the results of the research, the character-based comic media developed has several advantages and limitations which are explained as follows:

**Advantages of Character-Based Comic Media**

- 1. Comic media presents multiplication material visually and contextually, making it easier for students to understand abstract concepts.
- 2. The integration of character values in comic media not only helps students in the cognitive aspect, but also in the affective aspect.
- 3. The characters in the comics are close to the students' daily lives, making them easier to relate and internalize.
- 4. The digital format allows students to access comic media anytime and anywhere through a mobile app.

- 5. Engaging stories and visualizations increase students' motivation and interest in learning math.
- 6. Activities integrated in comics allow students to learn actively and interactively.

**Limitations of Character-Based Comic Media**

- 1. The development of comic media requires a relatively higher time and cost compared to conventional learning media.
- 2. The use of comic media in learning requires supporting devices such as smartphones or tablets.
- 3. The use of comic media in learning requires a supporting device such as a smartphone or tablet, which may not be equally available in all schools or students.
- 4. The allocation of learning time needs to be managed properly, because students tend to be too engrossed in the stories in comics so that they sometimes forget the mathematical concepts learned.
- 5. Comic media only focuses on multiplication material for grade III elementary school, so further development is needed for other mathematics materials.
- 6. Digital comic development requires specialized skills in graphic design and mobile app programming, which may not be mastered by all teachers.

**Differences with Previous Research and Research Novelty**

This research on the development of character-based comic media to improve mathematics learning outcomes has several differences and novelties compared to previous studies, as described in Table 7.

Table 7. Differences with Previous Research and Research Novelty

Yes	Aspects	Previous Research	This research
1	Format Media	The research of Devy Yuliastri Kurnia Putri (2015) and Tari (2020) developed mathematical comics in print form.	Developing math comics in a digital format that can be accessed through mobile applications, so that they are more interactive and in accordance with the characteristics of the native digital generation.
2	Character Value Integration	The research of Sukmawati et al. (2022) and Ani & Rosyidi (2021) focuses on the development of mathematical comics for concept understanding without explicitly integrating character values.	Integrate character values (honesty, hard work, responsibility, and cooperation) explicitly in comic media, with character reflections at the end of each chapter.

3	Materials and Approaches	The research of Manalu et al. (2017) developed a mathematical comic on trigonometric material for the high school level with a conventional approach.	Develop math comics on multiplication materials for elementary school level with a contextual approach that provides an authentic learning experience for students.
4	Interactive Features	Subroto et al.'s (2020) research developed a non-interactive math comic.	Develop digital math comics with interactive features such as animations, sounds, and quizzes that students can respond to directly.
5	Local Context	Previous research generally used a general or global context.	Integrate the local context of South Sulawesi in the stories and characters of the comic, making it more relevant to students' lives.

The main *novelty* of this research lies in the integration of digital technology in the development of character-based mathematical comics that can be accessed through mobile applications. Unlike previous studies that developed comics in print form, this research produces digital comics that are more interactive, adaptive, and in accordance with the characteristics of the native digital generation.

In addition, this study also applies a contextual learning approach that provides an authentic learning experience for students, helps them visualize abstract mathematical concepts into concrete and meaningful in everyday life, and develops positive characters simultaneously. The integration of character values is done explicitly through reflection at the end of each chapter, which distinguishes it from previous studies that generally only focused on understanding mathematical concepts.

Based on the results of the research that has been presented, several important findings related to the development of character-based comic media to improve mathematics learning outcomes in elementary schools can be analyzed. The findings are described as follows:

### Comic Media as a Bridge of Abstract and Concrete Concepts

The character-based comic media developed has succeeded in becoming a bridge between abstract mathematical concepts and students' real experiences. This is in line with Piaget's theory of cognitive development, where elementary school students are at a concrete operational stage that requires visualization and contextualization of abstract concepts.

Through stories and images in comics, the concept of multiplication is presented in the context of everyday life that is close to the student's experience. For example, in chapter 1

"Multiplication as Repeated Addition", students are presented with a situation where Mia and Rio help Pak Doni count the number of fruits arranged in several baskets. This situation helps students understand that multiplication is basically a repetitive addition.

This contextual approach in comic media is in line with the opinion of Yuliariatiningsih (2016) who stated that the use of three-dimensional media through a contextual learning model can help students in finding new concepts. In this case, the comic medium provides a "three-dimensional" visualization through stories and images that help students construct their understanding of the concept of multiplication.

### Integration of Character Values in Mathematics Learning

One of the advantages of the comic media developed is its integration with character values. This integration is carried out both implicitly through the attitudes and behaviors of the characters in the comics, and explicitly through the reflection of the characters at the end of each chapter.

The results of the study showed that there was an increase in the internalization of character values in students after the implementation of comic media. This indicates that learning mathematics can not only be used to develop the cognitive aspect, but also the affective aspect of the student. These findings reinforce the opinion of Moniati et al. (2022) who stated that character education is very important for students today, given the attitudes and morals of students who are increasingly concerned.

The integration of character values in mathematics learning through comic media is also in line with the goal of national education, which is to develop the potential of students to

become human beings who believe and fear God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens.

### Utilization of Digital Technology in Mathematics Learning

The development of comic media in digital format that can be accessed through mobile applications is a response to the development of the times and the needs of students in the digital era. This is in line with the opinion of Siregar et al. (2021) who stated that teachers are challenged to accommodate the development of the times and adjust to the conditions that occur by involving technology as a means of learning activities.

The digital format allows comic media to be equipped with interactive features such as animations, sounds, and quizzes that can increase student engagement in learning. In addition, the digital format also allows students to access comic media anytime and anywhere, thus supporting the concept of learning that is not limited by space and time.

The use of digital technology in mathematics learning also prepares students to face future challenges, where digital skills are becoming increasingly important. Thus, digital comic media not only helps students in understanding mathematical concepts, but also develops their digital literacy.

### Research Implications

Research on the development of character-based comic media to improve mathematics learning outcomes in elementary schools has several implications both theoretically and practically, as explained below:

#### Implicasi's theorem

1. This research strengthens Piaget's theory of cognitive development, particularly about the importance of visualization and contextualization of abstract concepts for students at the concrete operational stage.
2. The results of the study provide empirical evidence on the effectiveness of contextual approaches in mathematics learning, where students learn through real experiences and are relevant to everyday life.
3. This research enriches the literature on the integration of character education in

mathematics learning, which shows that mathematics can be used not only to develop the cognitive aspect, but also the affective aspect of students.

4. The results of the study contribute to the theory of multiple intelligences, which shows that comic media can accommodate a variety of student learning styles, such as visual-spatial, verbal-linguistic, and interpersonal.

### Practical Implications

1. For teachers, this research provides alternative learning media that can be used to improve students' mathematics learning outcomes while instilling character values.
2. For students, character-based comic media can help them understand math concepts more easily and fun, as well as develop positive characters.
3. For schools, the results of the research can be considered in developing a mathematics curriculum and learning program that integrates character education and digital technology.
4. For learning media developers, this study provides a character-based comic media development model that can be adapted to other materials or subjects.
5. For education policy makers, the results of the research can be a reference in formulating policies related to the development of learning media and the integration of character education in mathematics learning.

### Conclusion

Based on the results of the research and discussion, it can be concluded as follows:

1. The process of developing character-based comic media to improve mathematics learning outcomes in elementary schools has been successfully implemented by following the stages of the ADDIE (*Analysis, Design, Development, Implementation, Evaluation*) model. The development process begins with needs analysis, storyboard design, comic media development, implementation in learning, and evaluation of media effectiveness.
2. The character-based comic media developed has met the validity criteria with the category of "Very Valid" based on the assessment of mathematical material experts, learning

media experts, and character education experts. This high validity shows that comic media is suitable for use as a mathematics learning medium for multiplication materials in grade III elementary school.

3. Character-based comic media has also met the practicality criteria with the category of "Very Practical" based on the responses of teachers and students. This practicality shows that comic media is easy to use, efficient in learning, and beneficial for teachers and students.
4. The use of character-based comic media has been shown to be effective in improving students' math learning outcomes, with significant improvements in learning outcomes and N-gain being included in the medium category. The percentage of student learning completeness in the experimental group also increased significantly.
5. Character-based comic media successfully integrates character values (honesty, hard work, responsibility, and cooperation) in mathematics learning, with a significant increase in the internalization score of character values in students.
6. Teacher and student responses to character-based comic media fall into the "Very Positive" category, which indicates that comic media is interesting, useful, and practical in mathematics learning.
7. The character-based comic media developed has the advantage of visualizing abstract mathematical concepts, integrating character values, and utilizing digital technology that suits the characteristics of the native digital generation.
8. The novelty of this research lies in the integration of digital technology in the development of character-based mathematical comics that can be accessed through mobile applications, the application of contextual learning approaches, and the explicit integration of character values through reflection at the end of each chapter.

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