

## Development of ethnomathematics-based comic media: A study of Papalele culture

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### Abstract

This study is motivated by students' low ability to understand mathematics materials, particularly the System of Linear Equations in Two Variables (SLETV), as well as their limited ability to relate mathematical concepts to everyday life. The learning process, which is still teacher-centered and lacks the use of engaging instructional media, causes students to be less active and easily bored. In addition, the integration of local culture into mathematics learning remains very limited. This study aims to develop an ethnomathematics-based comic media that is valid, practical, and effective for teaching the topic of SLETV by incorporating the Papalele culture of Ambon City. The research employed a Research and Development (R&D) method using the ADDIE development model, which consists of the stages of Analyze, Design, Development, Implementation, and Evaluation. The subjects of this study were eighth-grade students of SMP Negeri 15 Ambon. The research instruments included validation sheets, observation sheets, teacher and student response questionnaires, and learning outcome tests. The results of the study indicate that the ethnomathematics-based comic media met the validity criteria with an average validation score of 3.51. The media was also considered practical based on positive responses from teachers at 88.9% and students at 82.8%. Furthermore, the media proved to be effective based on the t-test results, with a significance value of  $0.003 < 0.05$ , indicating a significant difference between the experimental class and the control class. Therefore, the ethnomathematics-based comic is appropriate for use in mathematics learning. The implications of this study show that integrating local culture into learning media can enhance students' motivation, engagement, and learning outcomes, while also helping preserve regional culture through education.

**Keywords:** Local Culture; Ethnomathematics; Comic; Papalele; Mathematics Learning

### 1. Introduction

The low academic achievement of students in mathematics has become a global issue that encourages developing countries to engage in various efforts to create positive changes within their societies (Yeh et al., 2019; Wu, 2025). A strong mastery of mathematics is believed to have a positive impact on developing countries, particularly in improving educational systems to build the future of younger generations, enhancing infrastructure, and strengthening economic knowledge, culture, morality, and the standard of living of society (Ayebale et al., 2020; Oikonomou, 2025). However, low mathematics learning achievement remains a persistent problem that may hinder developing countries from achieving their development goals. One of the main reasons for students' reluctance toward mathematics is their lack of understanding and low self-perception regarding content knowledge, which leads to negative perceptions of the subject. Students state that these negative perceptions are not new, but rather something they have experienced since elementary school. Many students still consider mathematics difficult and boring; therefore, contextual, engaging, and culturally relevant learning approaches are needed to improve students' motivation and understanding (Batlolona et al., 2019; Aguilar, 2021). Mathematical reasoning ability is regarded as one of the primary goals of mathematics education in schools (Laurens et al., 2018; Berge & Solberg, 2026). Mathematical competence is an essential skill that

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every citizen should possess because mathematics plays a role at various levels of understanding, including explaining, predicting, and analyzing phenomena (Maass et al., 2019). Furthermore, mathematics is considered one of the fundamental forms of literacy alongside mother-tongue literacy, second-language literacy, science, technology, engineering, arts and culture, computation or programming, financial literacy, and citizenship education. These competencies are viewed as key skills that students aged three to eighteen years should master in order to create a dynamic and continuously developing society capable of addressing challenges of change and sustainable national development (Muhtadi, 2022). Research findings indicate that there are various factors influencing students' self-confidence and academic achievement. Factors affecting mathematics achievement include student-related aspects such as low discipline, language barriers, and students' attitudes toward learning. From the teachers' perspective, influencing factors include limitations in knowledge and pedagogical skills related to content mastery, as well as inadequate professional training (Mabena et al., 2021). Studies also show that among students, 7% of children and adolescents have mathematics learning disabilities, while another 10% consistently demonstrate low achievement in mathematics despite having average abilities in most other areas. Children with mathematics learning disabilities and their peers with low achievement experience deficits in understanding and representing numerical quantities, difficulties retrieving basic arithmetic facts from long-term memory, and delays in learning mathematical procedures (Geary, 2011).

Research findings reveal developments in studies analyzing the mathematical literacy of Indonesian students at various educational levels, including elementary school, junior high school, senior high school, and university. At the elementary school level, students' literacy levels are still considered low, while at the junior high school level, mathematical literacy has been examined from various perspectives, ranging from low literacy achievement to the factors influencing it. At the senior high school level, students' mathematical literacy also remains low, even though mathematical literacy assessments have been conducted within the Indonesian context. Finally, at the university level, studies found that different student learning styles are associated with different levels of mathematical literacy ability (Juandi, 2022). The high percentage of students with low academic achievement is likely related to teacher-centered learning methods, which are still widely implemented in mathematics classrooms across many Asian countries. In fact, every student has different abilities, resulting in different learning achievements. However, in teacher-dominated learning environments, all students are required to understand the material in the same way and at the same pace (Hwang et al., 2015). As a consequence, low-achieving students often do not have sufficient time to understand the material and merely receive information passively. Barr & Tagg (1995) emphasized that students with lower abilities require more opportunities to learn mathematics according to their own learning pace. In addition, students can receive immediate feedback from Math-Island, which supports individualized learning processes in an active and effective manner. Therefore, this approach is expected to provide greater opportunities for low-achieving students to improve their learning outcomes. Several researchers have found that game-based learning can facilitate students' learning in terms of motivation and learning effects (Liu & Chu, 2010), spatial ability and attention (Barlett et al., 2009), contextual learning, and problem-solving skills (Li & Tsai, 2013). Considering these positive findings, it is expected that educational games can improve and sustain students' interest in learning mathematics. In fact, many researchers who have attempted to develop educational games for mathematics learning have demonstrated that such games can enhance mathematical performance, enjoyment, and self-efficacy (Ku et al., 2014; McLaren et al., 2017).

One of the learning media that can be applied in mathematics instruction is comics. Comics also provide a positive impact on teaching and learning activities (Mamolo, 2019). A study conducted by Sagri et al. (2018) found that comics can serve as a familiar and effective medium to support classroom learning processes. The use of comics has even been implemented in educational systems in various countries, such as elementary schools in France. In the United Kingdom, comics are utilized in various subjects including literature, art, and history, as well as in student-created comic projects. Meanwhile, in Japan, manga comics have been used in education for more than 25 years. In the United States, the use of comics has also begun to be implemented at various educational levels through the "Maryland Comic Book Initiative." Research has shown that the use of comics in mathematics learning effectively improves students' logical-mathematical intelligence in urban schools (Johar et al., 2023). The role of digital comic media in mathematics learning is to build positive emotional responses, focus students' attention, visualize abstract mathematical concepts into concrete concepts, and provide effective cognitive control for students during learning (Kusmaryono, 2025). Students' high interest in comics makes this medium capable of providing a unique contribution to mathematics learning activities and classroom discussions (Rahmi et al., 2022). Although comics were initially known as entertainment media, they can now be utilized as educational reading materials to help students understand lesson content. The illustrations contained in comics are capable of influencing readers' cognitive processes (Komalasari, 2019). As a visual medium that presents stories, comics make it easier for students to understand the material being studied. In addition, the storyline in comics can provide illustrations of various events that may have occurred in real life. Positive responses toward the use of digital comics indicate that this medium can help students focus more on understanding the material, thereby supporting the development of their conceptual understanding (Lazarinis & Panagiotakopoulos, 2015; Chen et al.,

2018). Digital comic representations of educational content have been proven to enhance students' comprehension, creativity, and narrative coherence (Sumarwati et al., 2021; Suwono et al., 2022). Comics also have the potential to make complex subject matter more accessible and can help students become more critical media consumers (Gu et al., 2019). Research conducted by Fitria et al. (2023) revealed that digital comic media is considered highly engaging and entertaining for children. This is due to its attractive appearance, the use of bright colors, and storylines capable of immersing children in the narrative world. The use of contexts closely related to daily life also makes it easier for children to understand and follow the storyline. Science material is presented through explanations connected to those contexts, making it easier to comprehend. In addition, children's thinking skills are trained through various questions embedded within the story narrative. These digital comics also instill positive values regarding good and bad behavior in different situations, encouraging children to make choices while taking responsibility for the decisions they make.

Based on interviews with eighth-grade mathematics teachers at SMP Negeri 15 Ambon, it was found that students' ability to relate mathematical concepts to everyday life is still low. This is reflected in the average mid-semester examination score, which only reached 65.7. One of the main causes is the limited use of instructional media in the teaching and learning process. Topics such as the System of Linear Equations in Two Variables (SLETV) become difficult for students to understand because they struggle to construct mathematical models from real-life contexts. Learning processes that tend to be monotonous and lecture-centered, without the support of interactive media, further reduce students' engagement and understanding. Therefore, the use of contextual and visual learning media is highly necessary to improve the quality of mathematics instruction. Mathematics learning in the classroom that incorporates cultural elements is known as ethnomathematics. A study by Rosa & Orey (2011) explains that ethnomathematics is a field of study that examines the relationship between mathematics and culture. This approach presents mathematical concepts within the school curriculum by connecting them to students' cultural experiences and everyday lives. As a result, students can more easily understand meaningful relationships and deepen their understanding of mathematics. The implementation of ethnomathematics in the mathematics curriculum aims to make mathematics learning more relevant, contextual, and meaningful for students, while also improving the overall quality of education. In practice, the ethnomathematical perspective within the school mathematics curriculum can support students' intellectual, social, emotional, and political development through the utilization of their cultural backgrounds. This approach allows students to express knowledge, skills, and attitudes based on their own culture. Furthermore, an ethnomathematics-based curriculum provides students with opportunities to maintain their cultural identity while achieving academic success. One tangible form of this local wisdom is the existence of Papalele culture, which has become an inseparable part of the daily lives of the community, particularly in Ambon and its surrounding areas. Papalele is a widely recognized local term referring to individuals—generally women—who engage in informal economic activities, especially the traditional buying and selling of basic necessities. Based on this background, this study aims to develop a mathematics learning medium in the form of an ethnomathematics-based mathematics comic by incorporating Maluku local culture, particularly the practice of Papalele.

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## 2. Methodology

### 2.1. Research Design

This research and development study was conducted to provide a learning resource reference for students in understanding the topic of the System of Linear Equations in Two Variables (SLETV). The type of research employed was Research and Development (R&D) by adopting the Analyze, Design, Development, Implementation, and Evaluation (ADDIE) development model (Molenda, 2003). In this research and development process, an ethnomathematics-based comic on the topic of the System of Linear Equations in Two Variables (SLETV) was developed. The resulting product is expected to serve as a learning resource reference for students.

### 2.2. Research Subjects

The subjects of this study were eighth-grade students of SMP Negeri 15 Ambon. Out of the eight available classes, two classes with relatively similar average scores were selected, namely class VIII-7 with an average score of 65.8 and class VIII-8 with an average score of 65.6. The sampling technique used was non-probability sampling with purposive sampling. According to Tajik et al. (2024), purposive sampling is a sampling technique based on specific considerations or criteria relevant to the objectives of the research.

### 2.3. Research Procedure

The development of ethnomathematics-based comic media in this study referred to the ADDIE development model. This model consists of five main stages: Analyze, Design, Development, Implementation, and Evaluation. The stages of media development based on the ADDIE model are described as follows.

### *2.3.1. Analyze*

The analysis stage is the initial step in the ADDIE development model, which aims to identify the needs and problems occurring in the field, particularly in the mathematics learning process at SMP Negeri 15 Ambon. This stage includes problem analysis, needs analysis, and student characteristics analysis.

### *2.3.2. Design*

The Design stage in the ADDIE development model aims to systematically design instructional media based on the results of the students' and teachers' needs analysis conducted in the previous stage. In this study, the instructional media designed was an ethnomathematics-based mathematics comic developed according to the principles of the Merdeka Curriculum, which emphasizes student-centered learning and is grounded in local contexts and culture. At this stage, the researcher formulated learning objectives, designed the media, prepared scripts and storyboards, and planned assessment activities and student learning activities.

### *2.3.3. Development*

The purpose of this stage was to produce revised learning materials based on feedback from experts and trials conducted with students. This stage included: (a) expert validation, (b) readability testing, and (c) small-scale trials.

### *2.3.4. Implementation*

The implementation stage is the process of applying the developed and validated instructional materials in real classroom learning situations. The purpose of this stage was to assess the practicality and effectiveness of the ethnomathematics-based mathematics comic in supporting the teaching and learning process. At this stage, a large-scale trial was conducted to determine the extent to which the media could be broadly implemented in actual learning environments.

### *2.3.5. Evaluation*

The evaluation stage is the final step in the development process using the ADDIE model. The purpose of this stage was to assess the overall quality of the instructional materials, including aspects of validity, practicality, and effectiveness. Evaluation was conducted based on data collected from the previous stages.

## **2.4. Product Validation**

Validation was carried out by five validators consisting of material experts, language experts, and media experts. This validation process aimed to ensure that the developed ethnomathematics-based comic media met the criteria of validity, practicality, and effectiveness before being used in classroom learning.

## **2.5. Readability Test**

The readability test was conducted by one teacher and three students. The purpose of this test was to identify the use of language and terms that were not yet understood by users so that revisions could be made before the media was implemented more broadly in the learning process.

## **2.6. Product Trial**

The trials in this study were conducted in two stages: a small-scale trial and a large-scale trial. The small-scale trial involved six students who were not part of the main sample, with the purpose of obtaining initial feedback on the developed media. Subsequently, the large-scale trial was conducted in the experimental class, namely class VIII-7, using the ethnomathematics-based comic media in the learning process.

## **2.7. Research Instruments**

The instruments used in this study included: (1) validation sheets, (2) readability test sheets, (3) observation sheets for the implementation of instructional materials, (4) teacher and student response questionnaires, and (5) test instruments.

## **2.8. Data Analysis**

This study employed both qualitative and quantitative data analysis techniques. Qualitative data in the form of suggestions and comments from validators, teacher and student response questionnaires, and readability tests were

analyzed descriptively as the basis for revising the media. Meanwhile, quantitative data were analyzed through the calculation of average validation scores, responses, learning activity implementation, and test results.

$$\bar{x}_v = \frac{\text{total scores from all validators}}{\text{number of validators}}$$

Description:

$\bar{x}_v$  = average validator assessment score

Validation was conducted by five experts covering aspects of content, language, and media. The readability test involved one teacher and three students. The trials were conducted in two stages: small-scale (6 students) and large-scale (class VIII-7). Teacher and student activity data were analyzed using the percentage of implementation. Teacher and student responses were categorized as positive if they reached  $\geq 70\%$ .

**Table 1** Percentage Classification

| Average Score           | Classification             |
|-------------------------|----------------------------|
| $70\% \leq P_r < 100\%$ | Meets the Criteria         |
| $P_r < 70\%$            | Does Not Meet the Criteria |

The effectiveness of the media was analyzed through an independent sample t-test on the learning outcomes of students in the experimental and control classes. Prior to conducting the t-test, normality testing (Kolmogorov-Smirnov test) and homogeneity testing (F-test) were carried out using SPSS. The test results were used to determine whether there was a significant difference between the two classes in understanding the System of Linear Equations in Two Variables (SLETV) material using ethnomathematics-based comics.

### 3. Results

#### 3.1. Analyze Stage

The analysis stage was conducted to identify problems, needs, and student characteristics as the basis for developing ethnomathematics-based comic media. Based on observations and analyses conducted at SMP Negeri 15 Ambon, the mathematics learning process still tended to use conventional teacher-centered methods with minimal use of engaging instructional media. During the learning process, students were not actively involved, resulting in a monotonous learning atmosphere that was less compatible with students' visual and kinesthetic learning styles. This condition caused students to become passive and less motivated in participating in mathematics learning. Therefore, innovation in learning methods and instructional media is needed to make the learning process more engaging and interactive. The results of the needs analysis indicated that students of SMP Negeri 15 Ambon possess diverse cognitive abilities. In the topic of the System of Linear Equations in Two Variables (SLETV), some students still experienced difficulties in understanding abstract concepts. The lack of visualization and the absence of connections between the material and real-life contexts made it difficult for students to understand and relate mathematical concepts to their actual experiences. Therefore, a more contextual learning approach that is closely related to students' daily lives is needed in order to improve conceptual understanding. Furthermore, based on the analysis of student characteristics, it was found that students at SMP Negeri 15 Ambon were between 14–15 years old, but not all of them were fully capable of abstract thinking. Students considered mathematics learning to be boring because the instructional media used were still limited to textbooks and whiteboards. On the other hand, students showed greater interest in visual learning media such as comics, which they considered more engaging and easier to understand. Students also demonstrated interest in learning that incorporates local culture and the use of the Ambon dialect, as these were considered closer to their daily lives and social environment.

#### 3.2. Design Stage

At the Design stage of the ADDIE model, an ethnomathematics-based comic media aligned with the Merdeka Curriculum was designed. The learning objectives were formulated based on the Phase D Learning Outcomes for junior high school, particularly on the topic of the System of Linear Equations in Two Variables (SLETV) within real-life contexts. The design included storyboards featuring Maluku local culture to enhance students' relevance and emotional engagement.

Characters, settings, and illustrations were created in accordance with the students' environment. The comics were designed to be engaging, communicative, and suitable for visual-kinesthetic learning styles, while also incorporating the Ambon dialect. The initial comic concept included the title, characters, genre, target readers, learning materials, synopsis, and visual documentation of local community activities.



**Figure 1** Portrait of Papalele Before Editing



**Figure 2** Portrait of Papalele After Editing

### 3.3. Development Stage

At the development stage, expert validation, readability testing, and small-scale trials were conducted on the ethnomathematics-based comic that had been designed. Validation was carried out by five experts from the fields of Mathematics Education, Indonesian Language, and local culture. In addition, the readability test involved one teacher and three students to determine the clarity of the language and content of the comic. Furthermore, the small-scale trial was conducted with six randomly selected students over two learning sessions and concluded with a final test. The test results were then analyzed using Criterion-Referenced Assessment (CRA) to determine the feasibility of the developed instructional materials. The validation results of the ethnomathematics-based comic by the five validators showed an average score of 3.51, indicating that the instructional media was categorized as feasible for use. Based on the validation results, the validators provided several suggestions and recommendations regarding the development of the comic, covering aspects of content, language, and media appearance. These suggestions were then used as the basis for revising the ethnomathematics-based comic in order to improve its quality and suitability for learning needs. The readability test conducted by one teacher and three students showed that there were no words, sentences, or terms that were difficult to understand. This indicates that the language used in the comic was appropriate for the students' level of

understanding. Based on the readability test results and expert validation results, the instructional materials were declared ready to be used in the classroom field trial stage. The small-scale trial results showed an improvement in students' abilities after using the ethnomathematics-based comic. The students' average pre-test score of 20.29, which was categorized as very poor, increased to 80.07 on the post-test, categorized as good, after two learning sessions. Based on these results, the ethnomathematics-based comic was considered feasible to proceed to the large-scale trial stage with class VIII-7 students.

### 3.4. Implementation Stage

The large-scale trial of the instructional materials was conducted to determine the practicality and effectiveness of the ethnomathematics-based comic in the mathematics learning process. The trial was carried out through observations of learning implementation, teacher and student responses, and analysis of student learning outcomes in both the experimental and control classes. Based on the observation results of the implementation of instructional materials from teacher activities, the average percentage of teacher activities was 100% in Meeting I, 100% in Meeting II, 94.1% in Meeting III, and 88.2% in Meeting IV. These results indicate that all learning steps were implemented very well in accordance with the developed instructional materials. Furthermore, the observation results of student activities showed that the percentage of student activity reached 88.99% in Meeting I, 86.27% in Meeting II, 85.96% in Meeting III, and 86.87% in Meeting IV. Overall, the average percentage of student activity implementation reached 87.02%. These findings indicate that students were actively involved in the learning process using the ethnomathematics-based comic. The teacher responses toward the use of the ethnomathematics-based comic showed that the average percentage in the "strongly agree" category was 88.9%, while the "agree" category was 11.1%. Meanwhile, the "disagree" and "strongly disagree" categories both obtained 0%. This indicates that teachers gave very positive responses to the use of the instructional media. Student responses toward the use of the ethnomathematics-based comic also showed highly positive results. The average percentage of student responses in the "strongly agree" category was 82.8%, while the "agree" category was 17.2%. The "disagree" and "strongly disagree" categories both obtained 0%. Thus, students gave positive responses toward the use of the ethnomathematics-based comic in mathematics learning. Student learning outcomes were obtained through tests conducted after four learning sessions in two classes, namely class VIII-7 as the experimental class using the ethnomathematics-based comic and class VIII-8 as the control class using conventional learning methods. The testing was conducted to determine the effectiveness of the comic media through comparison of the learning outcomes of both classes.

### 3.5. Normality Test

The normality test was conducted to determine whether the learning outcomes of students in both classes were normally distributed.

**Table 2** Results of the Normality Test

| Class Type   | Sig.  | $\alpha$ | Conclusion   |
|--------------|-------|----------|--------------|
| Experimental | 0.200 | 0.05     | Accept $H_0$ |
| Control      | 0.161 | 0.05     | Accept $H_0$ |

Based on Table 2, the significance value for the experimental class was 0.200, while the control class obtained 0.161. Since the significance values for both classes were greater than  $\alpha = 0.05$ , it can be concluded that both classes were normally distributed.

### 3.6. Homogeneity Test

The homogeneity test was conducted to determine whether the combined data from both classes had homogeneous variance.

**Table 3** Homogeneity Test

| Class                    | Sig.  | $\alpha$ | Conclusion   |
|--------------------------|-------|----------|--------------|
| Experimental and Control | 0.299 | 0.05     | Accept $H_0$ |

Based on Table 3, the significance value obtained was 0.299, which was greater than  $\alpha = 0.05$ . Therefore, it can be concluded that the combined data from both classes were homogeneous.

### 3.7. Hypothesis Test

The hypothesis test was conducted to determine whether there was a difference in learning outcomes between the two classes. The purpose of this test was to measure the effectiveness of the ethnomathematics-based comic after implementation. If a significant difference in students' learning outcomes was found, then the ethnomathematics-based comic could be declared effective.

**Table 4** Results of the t-Test

| Class Type             | Sig.  | $\alpha$ | Conclusion   |
|------------------------|-------|----------|--------------|
| Eksperimen dan Kontrol | 0.003 | 0.05     | Reject $H_0$ |

Based on Table 4, the significance value obtained was 0.003, which was smaller than  $\alpha = 0.05$ . This indicates that  $H_0$  was rejected, or in other words, there was a significant difference in student learning outcomes between the experimental class and the control class.

### 3.8. Evaluation Stage

The evaluation stage aimed to assess the quality of the instructional materials in terms of validity, practicality, and effectiveness. Validity was obtained from expert assessments, which indicated that the materials were valid with revisions. Practicality was evaluated through observations and teacher responses, showing that the instructional materials were easy to use. Effectiveness was determined from the differences in learning outcomes between the experimental and control classes, which indicated that the instructional materials were effective in improving students' learning outcomes

**Table 5** Quality of the Instructional Materials

| Aspect        | Criteria   | Achievement                        |
|---------------|--|------------------------------------|
| Validity      | Average validator assessment score ( $R_s \geq 2.50$ )                   | Ethnomathematics-based comic: 3.51 |
| Practicality  | Percentage of positive teacher and student responses ( $P_r \geq 70\%$ ) | Teacher: 88.9% Student: 82.8%      |
| Effectiveness | t-test ( $\text{sig} < \alpha$ )   | 0.003 < 0.05                       |

## 4. Discussion

The results of the study indicate that the developed ethnomathematics-based comic media was able to improve the quality of mathematics learning on the topic of the System of Linear Equations in Two Variables (SLETV). The developed media was found to be valid, practical, and effective, making it suitable for use in the learning process. The success of this media can be seen from the increased student engagement during learning activities, the high positive responses from both teachers and students, and the improvement in students' learning outcomes after using the ethnomathematics-based comic media. These findings demonstrate that the use of engaging and contextual learning media can help students understand mathematical concepts more easily and meaningfully. The use of comics as a learning medium has proven to create a more enjoyable and interactive learning atmosphere. In this study, students appeared to be more active in discussions, asking questions, and solving mathematical problems compared to when they participated in conventional learning. This occurred because comics present the material through visuals and stories that are easier for students to understand. The findings of this study are consistent with the research conducted by Lestari et al. (2021), which stated that the use of mathematics comics through a contextual approach was effective in improving students' critical thinking skills and fostering positive character development in mathematics learning. The study showed that comic media could help students understand concepts through illustrations and stories closely related to their daily lives, making learning more interesting and less monotonous. In addition, the results of this study also support the research conducted by Farhan et al. (2024), which developed a culture-based mathematics e-comic on the topic of SLETV. The study demonstrated that culture-based e-comic media had a very high level of validity and practicality and was effective in improving the motivation and learning outcomes of junior high school students. The integration of culture into learning media makes it easier for students to understand mathematical concepts because the material is connected to their daily lives and social environment. In this study, the Papalele culture was used as the

context for presenting SLETV material, enabling students to relate mathematical concepts to buying and selling activities that they commonly encounter within the Maluku community.

The use of local cultural contexts helps students understand that mathematics is closely related to everyday life. The results of the study also indicate that the use of ethnomathematics in learning has a positive impact on students' conceptual understanding. The integration of local culture into mathematics learning helps students understand the material more concretely because they learn through experiences that are closely connected to their daily lives. These findings are consistent with the study conducted by Sunzuma (2025), which stated that ethnomathematics plays an important role in helping students understand, express, and apply mathematical concepts in real-life situations. The study also emphasized that the integration of culture into mathematics learning can enhance the relevance of instruction and help students develop a deeper understanding of mathematical concepts. The practicality of the ethnomathematics-based comic media in this study can be seen from the high positive responses of both teachers and students toward the use of the learning media. Teachers considered that the comic media helped explain the material in a simpler and more understandable way, while students felt more interested in learning through visual media compared to relying solely on textbooks and lecture methods. These findings are in line with the study by Lolang & Pratama (2026) regarding a STEM-based e-comic incorporating Toraja local wisdom, which showed that culture-based comic media has a high level of practicality because it is easy to use, engaging, and helps students understand mathematical concepts contextually. The study also explained that the use of local culture in learning media can increase students' learning motivation and provide a more meaningful learning experience. The effectiveness of the ethnomathematics-based comic media in this study is also reflected in the students' better learning outcomes compared to conventional learning methods. The statistical test results showed a significant difference between the experimental class and the control class.

This indicates that the ethnomathematics-based comic media was able to help students understand the concepts of the System of Linear Equations in Two Variables (SLETV) more effectively. These findings support the study conducted by, Putri (2024) which stated that mathematics comic media is effective in improving students' learning outcomes because it presents mathematical concepts through engaging narratives and illustrations. The study also showed that comic media can increase students' motivation and attention during the learning process, making it easier for them to understand the material being taught. In addition to improving learning outcomes, ethnomathematics-based comic media also helps create a more student-centered learning environment. During the learning process, students appeared to be more active in reading, discussing, and solving mathematical problems presented in the comics. This indicates that comic media can encourage students to learn independently and actively. These findings are supported by the research conducted by Viana & Mastur (2025), which stated that ethnomathematics-based e-comics can improve students' learning motivation and critical thinking skills because the learning process is connected to local culture that is closely related to students' daily lives. The use of culture-based contextual problems makes students more interested in exploring the mathematical concepts being studied. Overall, the results of this study demonstrate that ethnomathematics-based comic media has great potential as an innovation in mathematics learning. The use of visual media combined with local cultural contexts is able to create learning experiences that are more engaging, contextual, and meaningful for students. In addition to helping improve mathematics learning outcomes, the integration of local culture into learning also plays a role in fostering students' awareness of the importance of preserving and maintaining regional culture. Therefore, ethnomathematics-based comic media can serve as an effective alternative learning medium to support mathematics instruction that is more interactive, creative, and aligned with students' characteristics in the modern learning era.

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## 5. Conclusion

The description of the research findings indicates that the development of the ethnomathematics-based comic media has fulfilled the criteria of validity, practicality, and effectiveness, making it suitable for use in the learning process. The ethnomathematics-based comic media was declared valid based on the validator assessment results, which obtained an average score of 3.51. This score met the validity criterion because it exceeded the minimum required standard of  $\geq 2.50$ . These findings indicate that the developed media is appropriate in terms of content, design, language, and presentation of the material, thereby making it suitable as a learning medium to support students' understanding. In addition to being valid, the ethnomathematics-based comic media was also found to be practical for classroom use. The practicality of the media was reflected in the positive responses given by both teachers and students after using the media. Teachers' positive responses reached 88.9%, while students' positive responses reached 82.8%. Both results fulfilled the practicality requirement because they exceeded the established criterion of  $\geq 70\%$ . This indicates that the ethnomathematics-based comic media is easy to use, engaging, and helpful for both teachers and students in the mathematics learning process. Furthermore, the developed ethnomathematics-based comic media was proven to be effective in improving students' learning outcomes. Based on the statistical test results, the significance value obtained

was 0.003, which is smaller than  $\alpha = 0.05$ . This result indicates a significant difference between the learning outcomes of students who used the ethnomathematics-based comic media and those who learned through conventional methods. Therefore, it can be concluded that the use of ethnomathematics-based comic media has a positive effect on improving students' learning outcomes compared to conventional learning methods.

The implications of this study indicate that the use of ethnomathematics-based comic media can serve as an effective alternative learning medium for improving the quality of mathematics instruction. The presence of comic media that combines cultural elements with mathematical content is able to create a learning environment that is more engaging, enjoyable, and easier for students to understand. In addition, the integration of ethnomathematics into learning media helps students become more familiar with and appreciative of the local culture within their surroundings. The research findings, which demonstrate that the ethnomathematics-based comic media is valid, practical, and effective, imply that this media is suitable for use by teachers in classroom learning. Teachers can utilize comic media as an instructional innovation to enhance students' motivation, interest, and learning outcomes, particularly in mathematics, a subject that is often perceived as difficult and boring. The use of this media can also support the implementation of more interactive and student-centered learning. Furthermore, this study provides implications for the development of other learning media to pay greater attention to local cultural aspects as learning resources. The integration of culture into learning not only helps students understand the material contextually, but also contributes to the preservation of regional culture through educational activities. Therefore, ethnomathematics-based comic media can be used as a reference for developing innovative learning media for different subjects and educational levels.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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