

Toraja local wisdom e-comics with a STEM approach to improve mathematical concept understanding and problem-solving skills

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ABSTRACT

Mathematics learning is often perceived as difficult due to its abstract nature and the lack of contextual media that connect concepts to students' real-life experiences. However, Toraja culture contains various elements embedded with mathematical principles, such as symmetrical carving patterns, the geometric structure of Tongkonan, and traditional calculations in social practices. These cultural aspects can serve as meaningful visual and narrative contexts to support conceptual understanding. This study aims to develop a Toraja Local Wisdom E-Comic based on the STEM approach to enhance students' conceptual understanding and problem-solving skills in mathematics. The research employs the ADDIE model, consisting of analysis, design, and development stages. The e-comic is presented as an interactive digital medium integrating Toraja cultural stories with mathematical concepts and STEM-based explanations. Validation was conducted by material and media experts, while practicality testing involved students as users. Data were analysed using descriptive, quantitative, and qualitative methods. The results indicate high validity, with average scores of 4.72 for material aspects and 4.65 for media aspects. The practicality test yielded an average score of 4.66, indicating that the e-comic is easy to use, engaging, and effective in facilitating understanding through cultural context. Therefore, the e-comic is considered valid and practical, with strong potential to improve mathematics learning outcomes. Further research will examine its effectiveness in classroom implementation.



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INTRODUCTION

Mathematics is one of the disciplines that plays a fundamental role in developing students' logical, analytical, and systematic thinking skills. At various levels of education, mathematics is often a challenging subject due to its abstract nature and the need for strong conceptual understanding (Bennett et al., 2008; Kornia et al., 2022). Students often struggle to understand basic mathematical concepts such as geometry, relations, algebra, and problem-solving because the learning process remains procedural and lacks context. Many students memorise mathematical procedures without understanding the meanings of the concepts. As a result, problem-solving skills, which are an essential goal of mathematics learning, do not develop optimally (Sudadi et al., 2023).

These difficulties are exacerbated when learning focuses solely on verbal explanations, symbolic abstractions, and repetitive exercises (Widodo et al., 2025; Kurniasih et al., 2025). In fact, mathematics learning will be more meaningful if students can relate mathematical concepts to real-life phenomena that they are familiar with (Chen & Tsai, 2021; Gravett et al., 2021). The contextual teaching and learning perspective emphasises that abstract concepts must be brought into everyday situations so that students can build meaningful cognitive structures (Madekhan, 2020; Azmi & Ummah, 2021). In this context, the use of learning media that are close to local culture is a very promising approach for connecting mathematical concepts with students' everyday experiences (Aries, 2023).

Indonesia has extraordinary cultural diversity, and each region offers visual, symbolic, and mathematical representations that can serve as a learning context (Lubis et al., 2022; Yudistira et al., 2022). One culture rich in mathematical elements is the Toraja culture in South Sulawesi. Toraja is known for its rich traditions, carved symbols, geometric patterns, traditional calculations, and the architectural structure of Tongkonan, which has symmetry, proportions, and geometric shapes closely related to mathematical concepts (Embon, 2019; Tandira'pak, 2022; Ikramah et al., 2022; Pasoloran et al., 2023; Ratnawati, 2019). Toraja carvings, for example, contain symmetrical patterns, rotations, reflections, and translations, which are core elements of transformational geometry. Similarly, the structure of the Tongkonan roof includes certain proportions and ratios that can serve as a context for discussing concepts of comparison, measurement, and simple trigonometric calculations. However, the potential of Toraja culture as a means of learning mathematics has not been optimally utilised in modern learning media.

In today's era of digital transformation, learning media need to keep pace with developments in information technology in order to attract the interest of young people who are familiar with digital devices (Pakoglean et al., 2024; Sutardi, 2022; Tulungen et al., 2022). One form of digital media that is effective for conveying material visually and narratively is e-comics. E-comics enable the conveyance of mathematical concepts through stories, illustrations, dialogue, and attractive visualisations, thereby helping students gradually understand abstract concepts (Filjjanan et al., 2022; Huda, 2021; Yudha et al., 2018). E-comics can improve students' scientific literacy and creative thinking skills because their visualisations are easy to understand. On the other hand, comics based on local culture have also been proven to strengthen identity, increase the relevance of learning, and build emotional connections between students and the material being studied (Cahyono et al., 2023; Huda, 2021; Wicaksana et al., 2020).

Although e-comics have been widely developed across various fields of learning, studies that integrate Toraja local wisdom with the STEM approach in the context of mathematics learning remain very limited. In fact, the STEM (Science, Technology, Engineering, Mathematics) approach is an integrated learning approach that helps students understand how mathematical concepts are used to solve real problems holistically (Prasetyo, 2017; Mulia, 2020). STEM encourages students to think across disciplines, use technology as a tool, and apply mathematical concepts in the engineering or problem-solving process. Thus, the integration of STEM and locally-based e-comics is a highly relevant combination for improving the quality of contextual, engaging, and meaningful mathematics learning (Angga et al., 2020; Kismawati et al., 2022).

Mathematical problem-solving skills are one of the key 21st-century competencies that students must master (Kornia et al., 2022; Sutrisno et al., 2020). According to Polya, problem-solving is a complex process that involves understanding problems, devising strategies, implementing them, and evaluating solutions. Conventional mathematics learning, which emphasises only problem-solving procedures, is unable to optimally develop these skills. STEM-based e-comics have great potential to develop problem-solving skills because they can present contextual, challenging, and realistic problem situations, thereby encouraging students to think critically and creatively in finding solutions (Hamimah et al., 2022; Samal et al., 2021). The stories and visuals presented in e-comics allow students to understand the problem's flow, visualise mathematical information, and independently explore the steps to solve it. Previous studies have shown that e-comics can improve engagement and conceptual understanding, while STEM-based learning enhances problem-solving skills. However, most of these studies use decontextualised

content without strong cultural integration. Conversely, research on local wisdom or ethnomathematics highlights the importance of cultural context but is generally limited to traditional or non-digital media. In addition, studies combining STEM and digital media often emphasise interdisciplinary learning but often overlook culture as a central component. As a result, the integration of culture, STEM, and digital media remains partial and fragmented. This study addresses this gap by integrating Toraja local wisdom, the STEM approach, and interactive e-comics into a unified learning design. Unlike previous research, local culture is positioned as the core foundation for constructing mathematical concepts and for problem-solving activities, rather than merely as a supplement. Therefore, the novelty of this research lies in its holistic integration of culture, technology, and STEM, offering both pedagogical innovation and a contribution to cultural preservation through digital learning media.

Furthermore, the use of local wisdom in learning media provides additional benefits, including strengthening students' character and cultural identity. Integration of local cultural values into learning can foster a sense of pride, deepen understanding of society's moral values, and enrich the learning experience (Irvan et al., 2017; Tadius & Salu, 2021). In the context of Toraja, values such as cooperation, precision in carving, and discipline in traditional rituals can serve as inspiration for applying the STEM approach. This contributes to students' character development while preserving Toraja cultural values in modern education. However, the reality on the ground shows that mathematical content is still rarely packaged in local cultural narratives, especially in interactive digital media. Most mathematical learning media are still textual, linear, and lack challenge. Students find it difficult to understand concepts due to a lack of visualisation and minimal real-world context. Therefore, the development of Toraja Local Wisdom E-Comics grounded in STEM is highly relevant for addressing these needs (Aprilia et al., 2023; Suryani et al., 2023). This medium not only combines cultural elements and visual storytelling but also includes step-by-step, systematic presentations of mathematical problem-solving.

This e-comic development research focuses on creating interactive media prototypes featuring illustrations of Toraja culture, context-based mathematical explanations, and STEM-based problem-solving activities. This development is very important as a learning innovation that can replace conventional media that is less appealing. By utilising digital platforms such as FlipHTML5 or illustration applications, e-comics can be presented in a responsive format, easily accessible via mobile devices or laptops, and equipped with interactive features that enhance user engagement. Furthermore, this research is part of efforts to decolonise the curriculum, in which local culture is not merely used as a supplement to learning but becomes the core context of mathematical knowledge. This aligns with the direction of the Merdeka Curriculum policy, which emphasises context-based learning, experiential learning, projects, and the integration of local culture across various subjects. Thus, the development of this e-comic is not only a media innovation but also a contribution to strengthening cultural identity and improving the quality of learning in higher education. Based on this description, this research is very important for filling the gap between the needs of modern mathematics learning and the rich mathematical potential of local culture.

The Toraja Local Wisdom E-Comic with a STEM Approach is expected to serve as a learning medium that improves students' understanding of mathematical concepts while developing their problem-solving skills through a visual, contextual, and interdisciplinary approach. To strengthen the state of the art, recent studies indicate that STEM-based digital learning media, particularly e-comics, have significant potential to enhance students' conceptual understanding and engagement. However, most existing studies focus on general contexts and rarely integrate local cultural wisdom as the core learning framework. Previous research has developed STEM-based e-comics or ethnomathematics-based learning separately, but few studies have combined local wisdom, STEM, and digital narrative media in a single integrated design. Therefore, this study offers a novel contribution by integrating Toraja local wisdom into STEM-based e-comics for mathematics learning. Unlike prior studies, this research positions local culture not merely as contextual support but as the main narrative foundation for constructing mathematical understanding. This approach contributes both pedagogically (innovative contextual learning

media) and culturally (preservation of local wisdom through digital education). Hence, this study fills the gap between culturally relevant pedagogy and technology-integrated STEM learning.

METHOD

This study utilised the Research and Development (R&D) method with the ADDIE model, comprising five main stages: Analysis, Design, Development, Implementation, and Evaluation. This model was chosen because it provides a systematic and appropriate framework for producing digital learning media products, such as e-comics, grounded in local wisdom and a STEM approach. In the year of this study, the main focus was on the first three stages, namely needs analysis, media design, and initial product development, along with feasibility testing. In contrast, the implementation and effectiveness evaluation stages will be carried out in the following year's study.

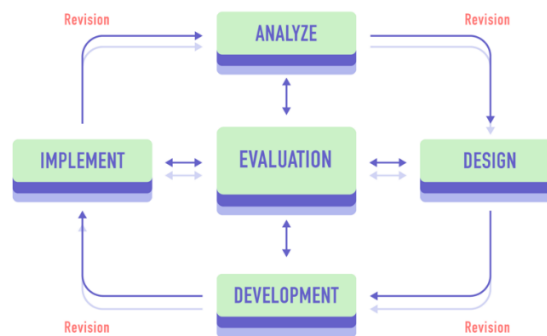


Figure 1. ADDIE Model

Analysis

The analysis stage was conducted to identify the needs of students and lecturers, as well as the relevant mathematics learning context. Data collection was carried out through needs questionnaires, preliminary interviews, and observations of ongoing learning patterns. An analysis of the mathematics material was also conducted to determine the appropriate concepts to include in the e-comics, such as geometry, patterns, and problem-solving. In addition, a study of Toraja culture was conducted to select cultural elements suitable for use as visual and narrative contexts, such as the geometric structure of Tongkonan, symmetrical carving patterns, and traditional activities that have mathematical connections. The results of this analysis form the basis for the design of contextual and meaningful media.

Design

The design stage involved compiling the storyline, initial storyboard sketches, e-comic page structure, and determining the visual design and illustration style. At this stage, the researchers also mapped out how STEM elements would be narratively integrated into the story. They designed a storyline that combined local cultural phenomena with mathematical problems the comic's characters had to solve. The design is created with consideration for readability, visual appeal, page proportions, and the integration of learning elements such as problem-solving exercises, brief concept explanations, and mathematical visualisations.

Development

The development stage is the process of producing a prototype version of the e-comic. The e-comic is developed in an interactive digital format using illustration software and a flipbook platform. Illustrations of Toraja culture are combined with mathematical concepts and narrative dialogue to guide students in understanding and thinking critically as they solve problems. After the initial prototype was completed, it was validated by experts, namely mathematics subject matter

experts and digital learning media experts. The validators assessed the suitability of the content, the accuracy of the concepts, the cultural appropriateness, the quality of the visual design, and the suitability of the media with STEM principles. The validation results were then used to revise the prototype. After revision, a practicality test was conducted with students using a questionnaire to assess ease of use, attractiveness, clarity of instructions, and the benefits of the media in mathematics learning.

Validity Test Assessment Scale (Subject Matter Experts and Media Experts)

The validity test involved two groups of experts: mathematics subject-matter experts and digital learning media experts. The purpose of the validity test was to ensure that the e-comics developed met the requirements of content appropriateness, conceptual accuracy, design quality, and cultural suitability, as reflected in the comics' narratives and illustrations. Subject matter experts assess the accuracy and completeness of mathematical concepts, the relevance of STEM integration, and the integration of Toraja local wisdom and mathematical learning objectives. The assessment also covers the logic of the storyline, the clarity of concept presentation, and the consistency of the material with the applicable learning outcomes. Meanwhile, media experts assess visual quality, layout, interactivity, page navigation, text readability, and the suitability of the e-comic format for use in digital learning. Aesthetic aspects and the harmonisation of local culture in illustration design are also important considerations in media assessment. Both groups of experts provide assessments on a five-point Likert scale, ranging from 1 (very poor) to 5 (very good). This scale is designed to quantify product quality, thereby facilitating the analysis and interpretation of results. The higher the validator's score, the higher the product's suitability and quality. The average validity score is then converted into specific categories, such as "very valid," "valid," "sufficiently valid," or "less valid." A product is declared suitable if the average score is in the valid or very valid category (≥ 3.41).

Table 1. Media Expert Validation Likert Scale

No.	Score	Assessment Categories
1	5	Highly Valid
2	4	Valid
3	3	Sufficiently Valid
4	2	Invalid
5	1	Highly Invalid

Practicality Test Assessment Scale (Users/Students)

In addition to being assessed by experts, e-comics are also tested for practicality through evaluations by end users, i.e., students. The practicality test aims to determine the extent to which the media is easy to use, easy to understand, visually appealing, and useful in assisting mathematics learning. The aspects assessed in the practicality test include the ease of operating the e-comic, the clarity of the instructions for use, the readability of the story and mathematical text, visual appeal, the clarity of the illustrations of Toraja culture, and the extent to which the media helps students understand concepts and solve mathematical problems. The assessment also covers students' perceptions of learning motivation and their comfort with using media on digital devices. The practicality instrument uses a five-point Likert scale, with categories ranging from 1 (not practical) to 5 (very practical). These score categories provide an overview of the practicality of the media from users' perspectives. The media is considered practical if the average score is ≥ 3.41 , and very practical if the average score is ≥ 4.21 .

Table 2. Likert Scale of Practicality

No.	Score	Category
1	5	Very Practical
2	4	Practical
3	3	Quite Practical
4	2	Less Practical
5	1	Impractical

In this year of research, the study was limited to the development stage, including needs analysis, design, prototype creation, expert validation, and practicality testing. Large-scale implementation and testing of the media's effectiveness were not carried out at this stage. These stages will be the focus of next year's research, so that the work produced this year will be a prototype e-comic that has been declared valid and practical from the perspective of early users, but has not been empirically tested for its effectiveness in improving mathematical concept understanding and problem-solving skills. Thus, the implementation and evaluation stages will continue in the next phase of the research to obtain comprehensive evidence on the impact of using e-comics in mathematics learning.

RESULTS AND DISCUSSION

Results

This section presents the findings from the development of the Toraja Local Wisdom E-Comic using the STEM approach. The results are organised according to the ADDIE model, focusing on the Analysis, Design, and Development phases completed in this study. Each stage provides important insights into how the product was systematically developed, validated, and tested for practicality. The presentation of the results begins with the needs analysis, which explores the learning conditions, student difficulties, and the potential of integrating Toraja local wisdom into mathematics learning. This is followed by the design stage, which describes the development of the storyline, visual elements, and STEM integration within the e-comic. Furthermore, the development stage outlines the production of the e-comic prototype, including expert validation and user practicality testing.

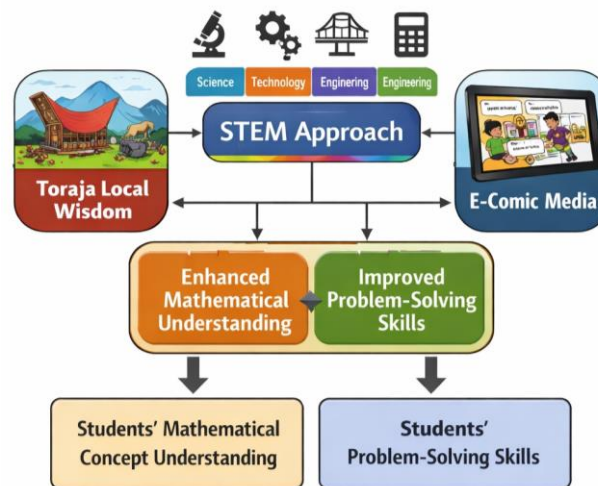


Figure 2. Conceptual Framework of the Study

Through this structured presentation, the results not only demonstrate the feasibility of the developed media but also provide a comprehensive understanding of how cultural context and STEM principles can be effectively integrated into digital learning media. These findings serve as the basis for further discussion of the relevance, strengths, and potential impact of the developed e-comic in improving students' understanding of mathematical concepts and problem-solving skills.

Requirements Analysis

The analysis stage was conducted through preliminary observations, interviews with lecturers teaching Basic Mathematics at Universitas Kristen Indonesia Toraja, and the distribution of questionnaires to 35 second-semester students. The purpose of this stage was to identify the need for innovative, contextual and engaging learning media. Key findings:

- a. As many as 82.8% of students stated that they had difficulty understanding abstract mathematical concepts, particularly in relation to force, pressure and energy.

- b. 74.3% of students mentioned that the learning media used were still conventional (PowerPoint and textbooks), making them less interesting.
- c. 91.4% of respondents stated that media that incorporated local Toraja culture could increase their interest in learning.
- d. Lecturers also emphasised the need for visual and narrative-based media, which could explain scientific concepts through real-life contexts.

In addition, an analysis of the Toraja local culture was conducted to determine relevant elements of local wisdom. As a result, three cultural contexts were selected for integration into the comic:

- a. The structure of the Tongkonan as a representation of the concepts of force and balance.
- b. The Rambu Solo' and Rambu Tuka' ceremonies to explain the principles of energy, force, and pressure.
- c. The traditional Toraja rice field irrigation system to illustrate the concepts of fluid and hydrostatic pressure.

This stage establishes a strong conceptual foundation for media design through a contextual, meaningful STEM approach.

Design

During the design stage, the research team compiled the script and storyboard for the e-comic and designed the main characters. It determined the storyline that illustrates the application of mathematical concepts in the lives of the Toraja people. Design results:

- a. The story script consists of five chapters, each covering a different mathematical topic within the context of Toraja culture.
- b. The visual storyboard was developed using the ADDIE instructional design approach, integrating aspects of Science, Technology, Engineering, and Mathematics (STEM) into each chapter.
- c. The dialogue between characters is designed to foster scientific thinking and problem-solving, not just entertaining narration.
- d. The visual design uses a combination of 2D digital illustrations and light animated elements, adapted for an interactive flipbook format that can be accessed via laptop and smartphone.

Key components of e-comic design: (1) Opening page: introduction to Toraja cultural context; (2) Interactive storyline: presents mathematical problems in traditional life; (3) Interactive exercises (reflective quizzes): help students test their understanding of concepts; (4) STEM and culture summary: emphasises the connection between science and local wisdom. From the initial design test involving five students, positive responses were obtained, with average scores of 4.35 out of 5 for visual clarity and 4.22 out of 5 for narrative flow.

Development

The development stage produced a digital version of the e-comic (prototype 1) using the FlipHTML5 application.

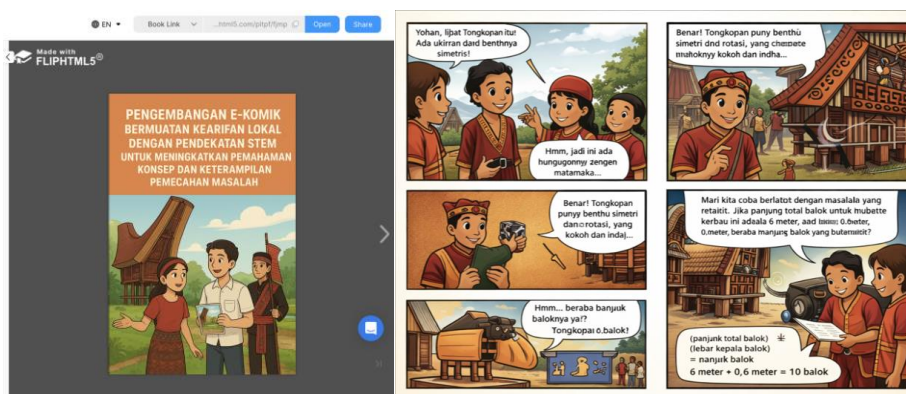


Figure 3. Flipbook-based E-Comics

This product comes with light animation and interactive page transitions. Audio narration in the cultural dialogue section. Interactive multiple-choice quiz-based exercises to test understanding of mathematical concepts.

Material Validity Test

Validation was carried out by two lecturers specialising in Mathematics Education and one STEM expert. The aspects assessed included content suitability, scientific concept accuracy, and cultural integration.

Table 3. Material Validity Test

No.	Assessment Aspects	Average	Category
1	The truth of mathematical concepts	4,80	Very Valid
2	Cultural context integration	4,75	Very Valid
3	STEM integration	4,70	Very Valid
4	Relevance to learning outcomes	4,60	Valid
5	Language comprehension and narration	4,65	Valid

Average material validity score: 4.70 (highly valid category). Validators' comments suggested adding a glossary of local terms to help students better understand the cultural context.

Media Validity Test

Media validity testing was conducted by two experts in educational technology and graphic design. The aspects assessed included visual appearance, interactivity, navigation, and audio-visual quality.

Table 4. Media Validity Test

No.	Assessment Aspects	Average	Category
1	Visual design and illustration	4.80	Very Valid
2	Interactivity and navigation	4.60	Valid
3	Consistency of appearance	4.75	Very Valid
4	Graphics and audio quality	4.50	Valid
5	Text readability	4.70	Very Valid

Average media validity score: 4.67 (highly valid category). The main suggestions are to increase the text size on mobile devices and slow down page transitions.

Media Practicality Test

The practicality test was conducted on 10 students of the Mathematics Study Programme at Universitas Kristen Indonesia Toraja through a user response questionnaire.

Table 5. Practicality Test

No.	Assessment Aspects	Average	Category
1	Ease of use	4.60	Very Practical
2	Appealing appearance	4.75	Very Practical
3	Clear instructions and navigation	4.55	Practical
4	Engagement in learning	4.70	Very Practical
5	Benefits for conceptual understanding	4.65	Very Practical

Average practicality score: 4.65 (very practical category). Students stated that e-comics helped them understand mathematical concepts more quickly because the storyline was directly related to phenomena around them. This medium has met the eligibility criteria for use in limited trials (implementation stage). In addition to serving as a learning medium, these e-comics also strengthen the preservation of Toraja local culture by integrating cultural values and symbols into scientific narratives.

Discussion

The results of the study indicate that the Toraja Local Wisdom E-Comic with a STEM Approach developed is highly valid and practical, as evidenced by expert and user assessments. These findings show that integrating local cultural visuals, the STEM approach, and mathematical content can produce high-quality learning media that is relevant to students' needs. This discussion elaborates on these results by linking them to theory, previous research, and the context of culture-based mathematics learning. First, the validity test results show that the e-comic received an average score of 4.72 from subject matter experts and 4.65 from media experts, indicating high validity. This means the mathematical concepts presented are accurate, systematic, and aligned with the learning outcomes. The integration of Toraja local wisdom is considered to support conceptual understanding by presenting concrete contexts relevant to students' lives. These findings reinforce the view that culture-based learning can clarify abstract concepts and help students construct meaningful cognitive structures. The use of Toraja cultural elements, such as symmetrical carving patterns, the geometric structure of Tongkonan, and calculation-based traditional activities, proved effective as a bridge to understanding abstract mathematical concepts (Sihombing et al., 2022; Syafe'i & Effendi, 2020). Secondly, from a STEM perspective, e-comics are considered to have consistently integrated elements of Science, Technology, Engineering, and Mathematics into their narratives (Amicis et al., 2019). This is evident in how mathematical problems are linked to cultural phenomena and solved through scientific thinking, simple technological analysis, and problem-based engineering approaches. These findings align with Sunismi (2015), who states that STEM-based media can facilitate learners' understanding of concepts through authentic, contextual problem-solving. Thus, e-comics not only present information but also offer interdisciplinary learning experiences that stimulate higher-order thinking skills.

Third, the practicality test conducted by students yielded an average score of 4.66, indicating that e-comics are very easy to use, interesting, and useful for learning. Students stated that the presentation of mathematical material became easier to understand when it was accompanied by visual illustrations, stories, and problems familiar to their culture. This reinforces the research of Cahyono et al. (2023), which found that comic media can improve conceptual understanding through narratives that reduce cognitive load and help learners build better mental representations. The visual appeal and interactivity of e-comics have also been shown to increase student motivation and interest in learning, in line with Keller's ARCS theory, which states that attention and relevance are key aspects of effective learning design.

Fourth, this study's results also show that integrating local wisdom into learning media positively strengthens students' cultural identity. For example, depictions of the Tongkonan structure, carving patterns, and authentic Toraja social contexts enrich the learning experience and evoke an emotional connection to the material. These findings are consistent with studies by Situru & Tulak (2022) and Tadius & Salu (2021), which show that local wisdom-based learning not only improves academic competence but also fosters cultural pride and character values. In other words, e-comics serve not only as a means of conveying mathematical concepts but also as a medium for cultural preservation. Furthermore, this study's results show that e-comics have the potential to improve mathematical problem-solving skills. This can be seen in the story structure, which invites students to face real-life, culturally based problems, analyse information, choose solution strategies, and draw conclusions. This aligns with Polya's problem-solving framework, which emphasises the need to present contextual, challenging problems to train critical thinking skills. Although effectiveness testing has not been conducted at this stage, this potential has been evident from students' positive responses during the practical testing.

However, this study has limitations: it reached only the development stage and did not include empirical implementation and effectiveness testing. Therefore, the results obtained are still limited to content validity and media practicality. The next stage must be carried out to determine the extent to which e-comics can significantly improve students' understanding of mathematical concepts and problem-solving skills. Overall, the study's results indicate that Toraja Local Wisdom E-Comics with a STEM Approach are a feasible, practical, and promising learning medium for mathematics education. This medium not only presents concepts visually and narratively, but also

provides a contextual, interesting, and meaningful learning experience. These findings make an important contribution to the development of culture-based and STEM learning media and open the door to further research to test their effectiveness in broader learning contexts.

CONCLUSION

This development research produced a Toraja Local Wisdom E-Comic with a STEM Approach, intended as a mathematics learning medium to help improve students' conceptual understanding and problem-solving skills. Based on the entire series of processes in the development stage, it can be concluded that the developed medium meets the criteria of validity and practicality, making it suitable for use in the implementation stage and for effectiveness testing in subsequent research. The validity test results from subject matter experts and media experts indicate that the e-comic received an average score in the highly valid category. This confirms that the mathematical content presented is accurate, logical, and consistent with the learning outcomes; the integration of STEM elements is structured and relevant; and the representation of Toraja culture is appropriately conveyed and supports conceptual understanding. The visual design, navigation, readability, and interactivity of the media were also rated as very good, making it attractive and easy for users to understand the information.

Practicality tests involving student users showed that the e-comic falls into the highly practical category. Students assessed that the e-comic is easy to use, visually appealing, clear in its presentation of mathematical concepts, and provides a real-world context that makes it easier for them to understand mathematical problems. This media is also considered capable of increasing learning motivation and providing a more enjoyable learning experience compared to conventional methods. The integration of Toraja local wisdom into e-comics has proven to provide significant added value. Cultural contexts such as traditional carving patterns, the geometric structure of Tongkonan, and traditional activities help students connect mathematical concepts to real phenomena close to their lives.

This strengthens the relevance of learning while preserving local cultural values through modern and creative educational media. Although this study has not yet reached the effectiveness testing stage, findings from the development stage indicate strong potential for e-comics to improve understanding of mathematical concepts and problem-solving skills. Therefore, further research is needed to conduct implementation tests in larger classrooms using experimental designs to obtain empirical evidence on the influence of media on student learning outcomes. Overall, this research makes an important contribution to the innovation of local culture-based and STEM learning media. The e-comics developed not only meet the quality standards for learning media, but also offer a contextual, engaging, and meaningful approach to improving the quality of mathematics learning in higher education and schools.

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