Electronic Journal of Education, Social Economics and Technology
Vol. 6, No. 1, (2025), pp. 755-765
ISSN 2723-6250 (online)
DOI: https://doi.org/10.33122/ejeset.v6i1.651

SAINTIS publishing

Research Article

Development of Culture-Based Interactive Comic Media to Improve Mathematical Literacy in Primary Schools

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ABSTRACT

This study aims to develop a culture-based interactive comic medium as an innovative tool to enhance mathematical literacy among primary school students. The research employed a Research and Development (R&D) method using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The analysis phase was conducted through observations and teacher interviews to identify appropriate media needs. The media was developed in the form of a comic incorporating local cultural contexts from Salatiga and material on whole number operations. Product validation was conducted by three experts, yielding results of 96% (media), 100% (content), and 100% (instructional design), all indicating a "highly valid" category. Effectiveness testing was carried out using pretests and posttests, showing an increase in the average score from 31.10% to 65.50%. Practicality testing showed results of 92% from students and 97% from teachers, both categorized as "highly practical." The results demonstrate that the culture-based interactive comic media is effective and feasible for improving mathematical literacy among primary school students.

Keywords: Interactive Comics; Local Culture; Mathematical Literacy; Media Development; Primary School

1. INTRODUCTION

Literacy is a crucial skill in human life (Bisri & Azis, 2024). It should be cultivated from an early age, as it helps individuals develop the ability to identify, discover, evaluate, organize, and effectively generate new knowledge, utilize it, and communicate it as part of problem-solving processes for both present and future challenges (Yanti & Riady, 2019). In the context of education, literacy is considered one of the key components to be learned and is a subject that must be introduced at the primary school level (Kusuma et al., 2022). A significant portion of the educational process relies on literacy awareness and skills, as a well-established literacy culture within students influences their academic success and their role in society. Twenty-first-century learning emphasizes not only literacy but also skills, attitudes, knowledge competence, and technological mastery (Zuhra & Septian, 2021). In order to enhance competitiveness in the 21st-century education era, students are expected to master six fundamental literacies: (1) language literacy, (2) numeracy literacy, (3) scientific literacy, (4) digital literacy, (5) financial literacy, and (6) cultural and civic literacy (Pangesti, 2018). Mastery of these six literacies must be supported by the development of critical thinking, creativity, communication, and collaboration skills (GLN Team, 2017). In line with Hartati (2016), literacy also includes comprehension responses and structured activities drawn from and applied in daily life.

The current phenomenon reveals numerous issues related to the erosion of literacy culture. The advancement of technology has not only affected adult literacy habits but has also significantly influenced school-aged children (Jatnika, 2019). Various electronic media such as television and gadgets have captured the attention of both children and adults, causing the practice of literacy to become increasingly neglected. In line with the findings of Mulasih and Hudhana (2020), their research indicates that the development of literacy culture among the public—particularly among children—remains minimal. This is evident in children's reading activities, where many only read one book per month, or in some cases, do not read at all. According to a survey conducted by the Programme for International Student Assessment (PISA) released by the Organization for Economic Co-operation and Development (OECD) in 2022, Indonesia ranked 69th out of 81 countries, indicating a low level of literacy.

This indicates that literacy remains a critical issue that needs to be addressed in Indonesia. In line with Pradana (2020), it is stated that the current reading interest index in Indonesia stands at 0.001, which means that only 1% of the population demonstrates a genuine interest in reading, while the remaining 99% show little to no engagement with literacy culture.

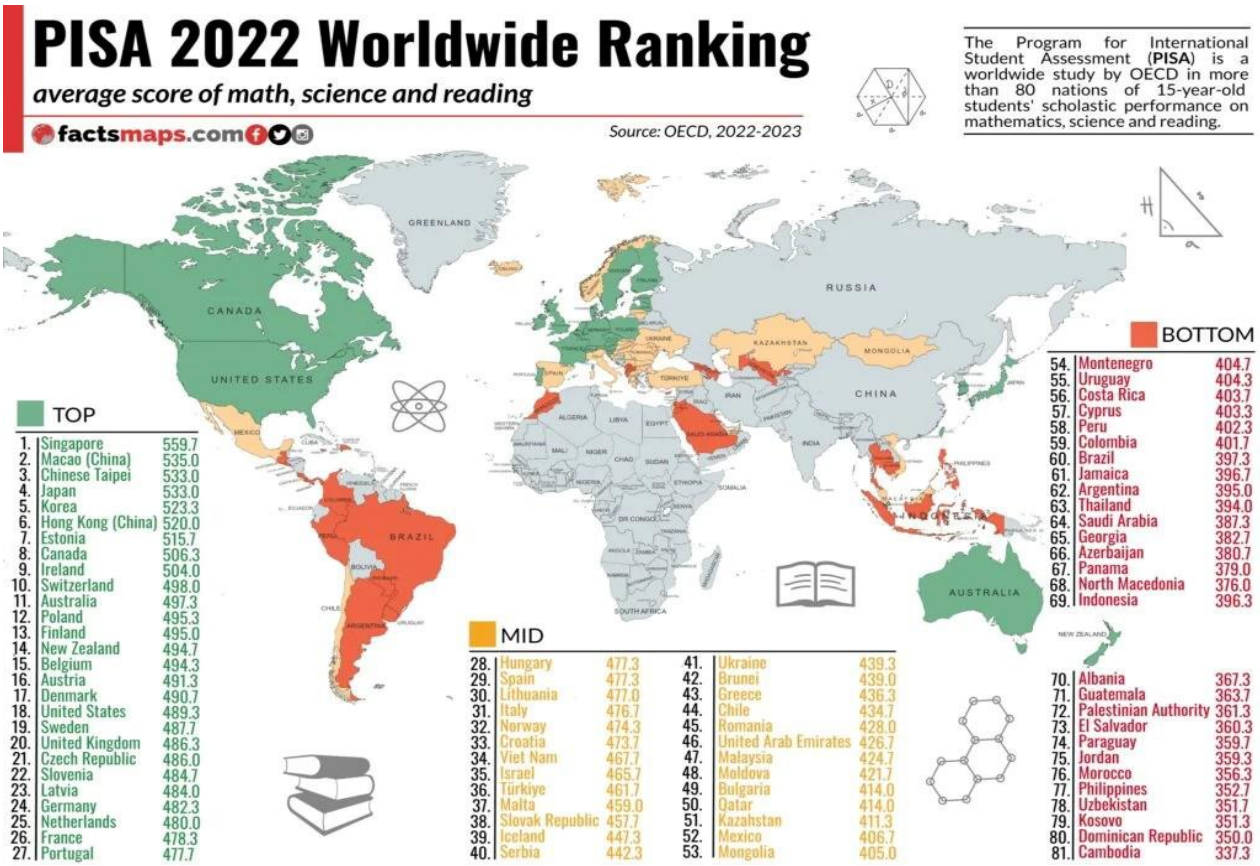


Figure 1. PISA Worldwide Ranking 2022

Furthermore, national assessment data from 2022 also revealed that literacy proficiency across all educational levels in Indonesia remains in the moderate category, with several regions still showing unsatisfactory literacy performance in their education reports. One of the contributing factors to the low literacy levels in Indonesia is the lack of attention from schools in providing adequate learning resources, limited access to reading materials, unappealing reading media, and environments that do not foster a strong reading culture (Dafit & Ramadan, 2020).

Figure 2. Education Report Data for the Year 2022

One of the reasons students are less interested in reading is that the reading materials provided often consist solely of text without images or colors, making them less engaging. Additionally, the books used are repetitive and lack variety, which causes students to become easily bored (Gogahu & Prasetyo, 2020). This is consistent with Witanto (2018), who states that the low literacy culture in Indonesia is partly due to limited reading facilities and infrastructure. Observations conducted by Nurwidiyanti and Sari (2022) at an elementary school in East Jakarta showed that although educators had made efforts to support literacy through printed books and Microsoft PowerPoint, these media failed to attract students' interest. As a result, students struggled to understand the lessons and did not develop strong literacy skills. Another study by Kusumandaru and Rahmawati (2022) emphasized that literacy sources are not limited to physical forms but can also include

digital media such as videos uploaded to social media platforms like TikTok. However, in practice, the use of TikTok often leads to reduced student focus on literacy learning. Students tend to become bored with educational videos and prefer to watch other, unrelated TikTok content. Moreover, the educational materials presented in such videos are often less detailed and less engaging. Given these circumstances, in order to cultivate reading as a hobby rather than merely an academic task, it is essential to foster a reading habit among students and make literacy activities enjoyable (Dalman, 2013). Literacy media for elementary school students must differ from other types of reading materials; for example, they should feature rich texts, vibrant colors, and appealing images that stimulate students' interest in reading and learning (Gogahu & Prasetyo, 2020). This is supported by Daryanto (2016), who notes that students tend to prefer illustrated reading media with colorful visuals presented in either realistic or cartoon formats. One medium that is particularly suitable for improving literacy culture is comics.

Interactive comics are an instructional medium that not only provide visual reading materials but also actively engage students through activities such as questions and exercises on each page. This approach fosters curiosity, involvement, and deeper conceptual understanding (Risti, 2021; Ningtyas & Wuryani, 2017). Interactive comics have been shown to motivate students and make learning more engaging compared to conventional teaching methods. While comics commonly feature fictional, humorous, mythological, or horror stories (Subroto et al., 2020; Prayoga, 2020), culturally-based stories are also highly appealing, as they introduce diversity and local wisdom values in a fun and enjoyable way (Pratiwi, 2017; Hutagalung & Ramadan, 2022; Bakti et al., 2018). Hidayah and Ulva (2017) emphasized that comic use generates high enthusiasm for reading and is often preferred over teacher explanations or videos. According to Resmi (2021), comics are also effective in enhancing literacy skills and making the learning process less monotonous. Observations by the researchers involving 20 fifth-grade students at SD Negeri Ledok 05 Salatiga revealed that learning still centered around textbooks and videos often led to boredom. However, when comic media was introduced, students showed significantly higher interest due to its colorful, illustrated, and visually appealing design. This indicates that fun and contextual comics can serve as an effective solution to the low reading interest and weak literacy culture in elementary schools. Furthermore, comics have also proven effective in mathematics instruction, as demonstrated by Putro and Dadang (2022) and Febriyandani and Kowiyah (2021), although both studies did not incorporate cultural elements into their comic development. Therefore, this study aims to develop a culture-based interactive comic as an innovative effort to enhance mathematical literacy among primary school students, particularly by contextualizing learning content within students' cultural environments, such as that of Salatiga.

2. RESEARCH METHOD

This study employed a Research and Development (R&D) method aimed at developing a culture-based interactive comic as a tool to enhance mathematical literacy among primary school students. The development model was based on the R&D steps proposed by Borg and Gall, which were simplified into three main stages by Sukmadinata (2016): the preliminary study, the design and development stage, and the product testing stage. During the preliminary study, the researchers conducted both literature review and field studies. The literature review explored relevant theories and previous research on interactive comics, local culture, and mathematical literacy. Meanwhile, the field study was carried out at SD Negeri Ledok 05 Salatiga through observations and interviews with fifth-grade teachers and students to identify actual classroom needs. The findings indicated that low mathematical literacy was due to a lack of engaging learning media and limited student involvement in the learning process. Based on these results, the researchers developed an initial draft of the product—an interactive comic that incorporated mathematical content with a local cultural theme from Salatiga, specifically focusing on whole number operations. The comic was visually designed using Canva, with colorful and contextually relevant illustrations. The development process followed the ADDIE model, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation. In the analysis stage, the researchers identified students' needs and challenges in learning mathematics. The design stage involved structuring the comic content based on learning objectives aligned with the Kurikulum Merdeka. During the development stage, the media was created and validated by three experts—content, media, and instructional design—using validation sheets that assessed content, appearance, visual communication, and instructional quality. Once declared valid, the comic was tested on a limited basis with 10 fifth-grade students at SD Negeri Ledok 05 Salatiga. The trial included a pretest and posttest using culturally contextualized open-ended questions to measure improvements in mathematical literacy. Additionally, data were collected using teacher and student response questionnaires to assess the product's practicality and acceptability. The data were quantitatively analyzed using the formula: AP = (Actual Score / Ideal Score) × 100%, and results were classified into five categories, ranging from very valid to invalid, and from highly appealing to very low. The evaluation stage provided the basis for final product revisions, ensuring readiness for broader implementation. Through this approach, the developed interactive comic is expected to increase student engagement and strengthen mathematical literacy in a fun and contextualized manner.

3. RESULTS AND DISCUSSION

The development of the culture-based interactive comic media to enhance mathematical literacy in primary schools was carried out using the Research and Development (R&D) method. This study aimed to examine the development process, as well as the validity, practicality, and effectiveness of the culture-based interactive comic media in improving mathematical literacy among primary school students. This section provides a detailed explanation of the research findings, focusing on the stages of developing the interactive comic media and its implementation in enhancing students' mathematical literacy.

3.1 Preliminary Study Results on the Development of Culture-Based Interactive Comic Media

The preliminary study was conducted through several stages: field study, needs analysis, and literature review. The field study involved observations and interviews with fifth-grade teachers and students at SD Negeri Ledok 05 Salatiga. Based on the results of interviews and observations carried out in February 2025, it was found that students lacked opportunities to engage in literacy activities, leading to low literacy levels, particularly in mathematical literacy. In fifth-grade mathematics learning, the teaching media used by teachers were limited to textbooks, worksheets (LKS), and instructional videos. This lack of engaging media resulted in students becoming bored and showing little interest in reading. As a solution to these findings, the use of interactive learning media was considered as a way to enhance mathematical literacy and encourage students to participate more actively in the learning process. The needs analysis was conducted through interviews and observations with fifth-grade teachers and students at SD Negeri Ledok 05 Salatiga, aiming to identify problems and determine the types of media required to improve mathematical literacy. The results of the needs analysis indicated a strong demand for innovative learning media, as current mathematics instruction employed very limited and monotonous media. Given these problems and needs, it became necessary to develop learning media that could both engage and stimulate students' interest. Therefore, comic media was proposed. The comics were developed into interactive, culture-based comics designed to improve students' mathematical literacy. A literature review was also conducted to describe the theoretical foundation for using culture-based interactive comics in enhancing mathematical literacy in primary schools. The review included an analysis of mathematics learning as outlined in the Kurikulum Merdeka, with the goal of identifying the appropriate Learning Objectives (Capaian Pembelajaran or CP) for implementing this media. The result of the curriculum analysis indicated that the topic *"Whole Number Operations up to 100,000"* was suitable for integration with the culture-based interactive comic media. To support the achievement of learning objectives through this medium, a structured instructional design or teaching module (*Modul Ajar*) was developed.

3.2 Results of the Design and Development of Culture-Based Interactive Comic Media

The development of the culture-based interactive comic media followed the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Based on these stages, the media development process was carried out through the following detailed steps:

1. Analysis

Based on the analysis conducted through observations and interviews with the fifth-grade teacher at SD Negeri Ledok 05 Salatiga, the following steps were carried out: (a) an analysis of the characteristics of the fifth-grade students, and (b) an analysis of the teaching materials used by the teacher. The results of the observations and interviews revealed that students tended to feel bored during lessons, particularly in mathematics. There was a lack of active learning activities that engaged students, and no attractive media were used to support mathematical literacy. As a result, students were not accustomed to thinking within the framework of mathematical literacy during the learning process. The teacher interviews further revealed that mathematics instruction mainly relied on worksheets (LKS), YouTube videos, and textbooks. The media used in class lacked innovation, particularly in terms of supporting and enhancing students' mathematical literacy. Based on these identified issues, the researcher developed a culture-based interactive comic as a learning medium aimed at improving students' mathematical literacy, thereby fostering greater interest and motivation in learning mathematics.

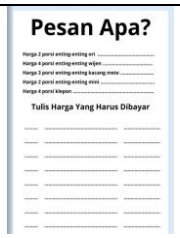
2. Design

Table 1. Components of the Culture-Based Interactive Comic Media

Descriptions	Figure					
Introduction						
	(a) Comic Cover	(b) Author Biography	(c) About the Comic	(d) Comic Characters	(e) Comic Reading Guide	(f) Table of Contents
Content						
	(a) Episode 1	(b) Mission 1	(c) Episode 2	(d) Episode 3	(e) Mission 2	(f) Episode 4

(a) Mission Menu Section

(b) Mission Menu List



(c) Mission Menu Question 1

(d) Mission Menu Question 1

Closing

(a) QR Game (b) *Cover* Penutup Komik

3. Development

The development process involved product validation by media experts, subject matter experts, and instructional design experts. The purpose of the validation process was to evaluate the depth and accuracy of the content in the developed product. At this stage, the development of the culture-based interactive comic included identifying relevant mathematics learning material to serve as the foundation for the product, determining the concept of the questions, structuring the storyline, and designing both the cover and internal pages of the comic. Validation was then carried out by media, content, and instructional design experts. Based on their feedback, revisions were made to the product. Once finalized, the validated product was distributed to students for implementation in the study.

Table 2. Summary of Validation Results Categories by Media Expert

No	Expert	Ideal Score	Actual Score	Feasibility Percentage	Feasibility Category
1	Media Expert	60	58	96%	Highly Valid
Overall Percentage				96%	

Based on the validation results by the media expert, a total score of 58 was obtained, with a feasibility percentage of 96%. Therefore, the level of validity assessed by the media expert falls into the "Highly Valid" category.

Table 3. Summary of Validation Results Categories by Subject Matter Expert

No	Expert	Ideal Score	Actual Score	Feasibility Percentage	Feasibility Category
1	Subject Matter Expert	50	50	100%	Highly Valid
			Overall Percentage	100%	

Based on the validation results by the subject matter expert, a total score of 50 was obtained, with a feasibility percentage of 100%. Therefore, the level of validity assessed by the subject matter expert falls into the "Highly Valid" category.

Table 4. Kesimpulan Kategori Hasil Uji Validitas Desain Pembelajaran

No	Expert	Ideal Score	Actual Score	Feasibility Percentage	Feasibility Category
1	Instructional Design Expert	65	65	100%	Highly Valid
			Overall Percentage	100%	

Based on the validation results from the instructional design expert, the product received a perfect score of 65, resulting in a feasibility percentage of 100%. This indicates that the instructional design of the culture-based interactive comic media is categorized as "Highly Valid" and is suitable for use in the learning process.

1. Implementation

Table 5. Pre-Test and Post-Test Validity Test Results

No	Pre Test Item	r count	r table	Description	No	Post Test Item	r count	r table	Description
1	Question1	0,148	0,632	Invalid	1	Question1	0,048	0,632	Invalid
2	Question2	0,439	0,632	Invalid	2	Question2	0,008	0,632	Invalid
3	Question3	0,778	0,632	Valid	3	Question3	0,524	0,632	Invalid
4	Question4	0,562	0,632	Invalid	4	Question4	0,872	0,632	Valid
5	Question5	0,779	0,632	Valid	5	Question5	0,891	0,632	Valid
6	Question6	0,682	0,632	Valid	6	Question6	0,891	0,632	Valid
7	Question7	0,716	0,632	Valid	7	Question7	0,900	0,632	Valid
8	Question8	0,648	0,632	Valid	8	Question8	0,978	0,632	Valid
9	Question9	0,784	0,632	Valid	9	Question9	0,726	0,632	Valid
10	Question10	0,761	0,632	Valid	10	Question10	0,679	0,632	Valid

The results of the pre-test instrument validity test showed that out of 10 items assessed, 7 items (items 3, 5, 6, 7, 8, 9, and 10) were considered valid because the calculated r-value exceeded the r-table value (0.632). Meanwhile, 3 items (items 1, 2, and 4) were deemed invalid as their r-values were lower than the r-table value, and thus were excluded from further testing. In the post-test validity test, 8 items (items 4 through 10) were found to be valid, while 2 items (items 1 and 2) were invalid due to having r-values below the r-table threshold. Consequently, only test items that met the validity criteria (r_{count} > r_{table}) were used to analyze improvements in students' mathematical literacy. These results indicate that the majority of the test items developed possessed good quality and were suitable for use as measurement instruments in this study.

Table 6. Reliability Test Results

No	Class	Cronbach's Alpha	Standard Cronbach's Alpha	Description
1	Pre test	0,864	0,7	Reliable
2	Post test	0,942	0,7	Reliable

The reliability test results indicated that the Cronbach's Alpha value for the pre-test was 0.864, and for the post-test, it was 0.942. These values exceed the minimum reliability threshold of 0.7, indicating that both the pre-test and post-test instruments are classified as reliable. This means that the instruments used have high internal consistency and are dependable for consistently measuring students' mathematical literacy. The high reliability also suggests that the items within the instrument are positively correlated and form a cohesive whole in measuring the intended construct.

Table 7. Descriptive Statistical Analysis

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Pre test	20	20	22	42	31,10	4,518
Post test	20	10	60	70	65,60	2,479
Valid N (listwise)	20					

Based on the descriptive table above, it can be seen that the students' average pre-test score was 31.10, while the average post-test score was 65.60. This indicates an increase of 34.50 points from the pre-test to the post-test. The results suggest that students showed improvement in understanding the flow of mathematical literacy presented in the material on whole number operations up to 100,000.

Table 8. Normality Test Results

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre Test	,246	20	,003	,914	20	,076
Post Test	,214	20	,017	,934	20	,182

a. Lilliefors Significance Correction

Based on the results of the normality test, the significance (Sig) values from the Shapiro-Wilk test were 0.076 for the pre-test and 0.182 for the post-test, both of which are greater than 0.05. It can therefore be concluded that the data are normally distributed.

Table 9. Paired Samples Test Results

Paired Samples Test									
		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	*Pre Test - Post Test*	-34,500	5,267	1,178	-36,965	-32,035	-29,296	19	,000

The results from the paired samples t-test show a mean difference of 34.500. This indicates a significant difference between the pre-test and post-test scores, demonstrating that the treatment had a meaningful effect. It can be concluded that the use of culture-based interactive comics had a significant impact on students' performance in mathematics, specifically in the topic of whole number operations up to 100,000.

4. Evaluation

The results from the T-test table show a mean difference of 34.500. This indicates that there is a significant difference between the pre-test and post-test scores, demonstrating that the treatment had a notable effect. It can be concluded that the use of culture-based interactive comics had a significant impact on students' learning outcomes in mathematics, specifically in the topic of whole number operations up to 100,000.

Table 10. Summary of Teacher Response Categories

Number of Teachers	Ideal Score	Actual Score	Feasibility Percentage	Feasibility Category
1	45	44	97%	Very Interesting
Overall Percentage			97%	

Based on the teacher's response, a total score of 44 was obtained, with a feasibility percentage of 97%. Therefore, the teacher's response falls into the "Very Interesting" category.

Tabel 11. Conclusion of the student response category

Number of Students	Ideal Score	Actual Score	Feasibility Percentage	Feasibility Category
20	1000	920	92%	Very Interesting
Overall Percentage			92%	

Based on the students' responses, a total score of 920 was obtained, with a feasibility percentage of 92%. Therefore, the students' responses fall into the "Very Interesting" category.

3.3 Discussion

The development of culture-based interactive comic media was carried out to support and enhance the use of instructional media in the mathematics learning process, as well as to improve students' mathematical literacy. The aim of this study was to determine the validity, effectiveness, and practicality of the culture-based interactive comic media in enhancing mathematical literacy at the primary school level. The development of the culture-based interactive comic media followed the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). This Research and Development (R&D) study underwent a feasibility testing phase and was evaluated by a media expert, a subject matter expert, and an instructional design expert to determine the quality and feasibility of the media before proceeding to the trial stage. The development of this media served as a strategic effort to address the need for more engaging and culturally relevant learning tools in mathematics education, specifically aimed at fostering mathematical literacy among elementary school students. The feasibility test results indicated that the media was categorized as “highly valid” by all three experts, confirming its appropriateness for use in classroom settings. This supports the idea that culture-based interactive comics can serve as an effective and engaging medium to improve mathematical literacy in primary education.

The analysis stage was carried out through observations and interviews with teachers to identify classroom conditions, student characteristics, and media needs. It was found that teachers relied solely on worksheets, textbooks, and YouTube videos, without the use of interactive media capable of enhancing mathematical literacy. Students were also easily bored and showed little enthusiasm during lessons. Based on these findings, there was a clear need for a culture-based interactive comic that could capture students’ attention and improve their mathematical literacy. According to OECD (2013a), mathematical literacy is the individual’s capacity to formulate, use, and interpret mathematics in various contexts. Comics were chosen due to their visual appeal, narrative structure that facilitates understanding, and proven effectiveness as a learning medium (Nurhakim et al., 2024; Ngazizah et al., 2022). The design stage began with the development of the product structure based on the analysis results, consisting of three main parts: introduction, content, and closing. The comic design

followed graphic elements such as space, image, text, point, line, and shape as outlined by Siregar & Siregar (2021), in order to produce a communicative and engaging comic. The development stage was based on the R&D methodology. After the product was designed, validation was conducted by three experts: media expert Dr. Dani Kusuma, M.Pd. (96% – highly valid), content expert Dr. Herry Sanoto, S.Si., M.Pd. (100% – highly valid), and instructional design validation by the same expert (100% – highly valid). These results indicate that the media is suitable for use in classroom instruction.

The implementation stage was carried out through field testing with fifth-grade students at a primary school. Pre-tests and post-tests were used to measure the effectiveness of the media. The normality test showed that the data were normally distributed (pre-test: 0.076 > 0.05; post-test: 0.182 > 0.05), allowing the continuation to a t-test. The pre-test had an average score of 31.10%, while the post-test average increased to 65.50%, indicating a gain of 34.50%. This demonstrates that the comic media had a significant effect on improving students' understanding. These findings are supported by studies conducted by Indaryati & Jailani (2015) and Udil & Sangur (2020), which also found that comic media can enhance mathematics learning outcomes. The evaluation stage was conducted by gathering responses from both students and teachers regarding the media. The questionnaire results showed that students gave a "very interesting" response with a score of 92%, and the teacher response reached 97%, indicating that the media is highly practical and suitable for classroom use. This study is in line with Rahmawati (2023), who developed a Javanese culture-based mathematics comic that received excellent feedback from students (95.23%) and was deemed feasible by experts (76%). Similarly, Yenzi (2023) found that a Jambi culture-based comic demonstrated high levels of practicality, with scores of 98% from teachers and 94.67% from students.

4. CONCLUSION

The results of this study indicate that the development of culture-based interactive comic media is proven to be effective in improving mathematical literacy among primary school students. The development process followed the ADDIE model, which includes the stages of needs analysis, product design, expert validation, field implementation, and evaluation of media effectiveness and practicality. Expert validation showed a very high level of feasibility, with scores of 96% from the media expert and 100% from both the content and instructional design experts. The effectiveness test, based on the comparison between pre-test and post-test results, revealed a significant improvement in student understanding by 34.5%. Additionally, the media was rated as highly practical, with a practicality score of 92% from students and 97% from the teacher. Therefore, culture-based interactive comic media can serve as an innovative alternative for mathematics learning—engaging, contextual, and effective in enhancing mathematical literacy in primary education.

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