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Needs Analysis for the Development of Culturally Themed E-Comic Media to Enhance Elementary School Students' Numeracy Skills

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Abstract

Technology-based learning media, such as e-comics, have great potential to attract students' interest in learning, thereby enhancing their numeracy skills. However, e-comics specifically designed to improve elementary school students' numeracy skills, especially those integrating local cultural elements, remain limited. This study aims to conduct a needs analysis for developing culturally nuanced e-comics as a learning medium to enhance students' numeracy skills. The research employs a developmental research method using the ADDIE approach, which in this study is limited to the analysis and design stages. Data was collected through interviews, observations, and questionnaires, then analyzed qualitatively. The subjects of this study consisted of 148 fourth-grade students and five elementary school teachers. The findings indicate that student's need media that can help them understand learning materials in an interactive and relevant way, particularly in mathematics related to data management. In addition, teachers expressed the need for innovative media that can bridge abstract mathematical concepts with real-life contexts familiar to students. The integration of local cultural elements not only provides contextual learning experiences but also fosters cultural awareness among students. The use of e-comics with cultural contexts is expected to increase students' learning interest, motivation, and engagement, thereby having positive potential to improve elementary school students' numeracy skills. These findings serve as a foundation for the design and development of interactive, culturally responsive digital comics in future stages.

Keywords: E-Comic, Literacy, Mathematics Learning Media, Numeracy.

Introduction

The advancement of science and technology has brought significant changes in various aspects of life, including education. In this era of globalization, every country is required to continuously innovate to improve the quality of education and produce a competitive generation (1, 2). Indonesia, with its abundant human resources, has great potential to leverage these developments to create a superior education system. The optimization of science and technology utilization plays a crucial role in achieving effective learning outcomes, supporting the formation of an adaptive, creative, and globally competitive generation (1, 3). This necessity drives countries to innovate, particularly in the field of education. As a country with a vast human resource base, Indonesia holds significant potential to produce outstanding generations in education. One of the key factors influencing educational success is the effective utilization of science and technology to achieve learning objectives. As a fundamental discipline underlying various fields of knowledge, mathematics plays a crucial role in developing logical, analytical, and problem-solving skills (4, 5). In the educational context, mathematics learning is not only aimed at teaching basic concepts but also at training students to face increasingly complex real-life challenges. The integration of technology into mathematics education can serve as an innovative solution to make learning materials more engaging, interactive, and relevant to modern needs (6, 7). As a fundamental field of study, mathematics continues to evolve alongside societal changes. The focus of mathematics education in the 21st century is to strengthen the 4C skills: critical thinking, communication, collaboration, and creativity. Numeracy literacy,

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which is closely related to mathematics, is a crucial competency for addressing 21st-century challenges. It is an essential component that not only supports mathematics learning but also plays a significant role in everyday decision-making. Numeracy literacy requires students to solve mathematical problems relevant to daily life (8–10). However, data indicate that Indonesian students' numeracy literacy skills remain low. Based on PISA scores, the average numeracy literacy score of Indonesian students is only 379, significantly below the OECD average of 489 (11). This situation serves as a critical reminder to enhance mathematics education through a more effective numeracy literacy approach. It highlights a gap between students' ability to understand mathematical concepts and their application in real-life situations, necessitating strategic solutions in the education sector. The current limitations faced by teachers in numeracy instruction reflect a multidimensional challenge encompassing aspects of knowledge, pedagogy, and resources. Many teachers, particularly at the elementary school level, continue to struggle with deeply understanding numeracy as part of contextual and applicable mathematical literacy, rather than merely mastering basic arithmetic operations. Furthermore, the lack of innovative, contextual, and culturally based learning media often results in monotonous teaching processes that fail to bridge students' understanding of numerical concepts in practical ways. Limited classroom time and the heavy administrative workload also hinder teachers from implementing differentiated instruction tailored to each student's numeracy needs. As a result, many students are unable to optimally develop their numerical thinking skills, particularly when solving mathematical problems that require cross-contextual understanding. Improving numeracy literacy can be achieved with learning media. These media serve as teaching aids to enhance students' comprehension of the material. Additionally, learning media plays a role in capturing students' attention and interest, thereby supporting the achievement of learning objectives (11, 12). One innovative learning medium that can be applied is e-comics, or digital-based comics. E-comics are designed to align with students' interest in technology-based media while also boosting their learning motivation (13). The use of e-comics enables more engaging, interactive, and relevant content delivery, suited to the digital world familiar to today's students.

Furthermore, mathematics education can be linked to ethno mathematics, which connects mathematical concepts with local culture. Ethno mathematics encompasses various cultural aspects such as language, beliefs, traditions, and mathematical activities like grouping and modeling (14, 15). In mathematics learning, ethno mathematics can be defined as an approach that integrates local, traditional, and cultural mathematical practices into the teaching-learning process to make mathematics more contextual, relevant, and meaningful for learners (16–18). However, in the digital era, students tend to be more exposed to foreign cultures through gadgets, often neglecting their own local heritage. Therefore, a solution that integrates mathematics learning with the introduction of Indonesian culture is necessary to enhance students' interest and motivation. Incorporating cultural elements into mathematics learning can be an effective strategy for fostering cultural awareness while also strengthening student engagement in learning (19). Within a cultural context, students gain a more contextual learning experience, which also has the potential to provide insights into history and cultural values.

Interviews with elementary school teachers reveal that many teachers are not accustomed to using learning media in the classroom, particularly digital learning media, due to time constraints and other factors such as infrastructure and digital literacy. Currently, mathematics instruction in classrooms is often limited to routine tasks focused on covering the curriculum, making it less effective as some students remain unmotivated and disengaged. Interviews with students also indicate that many are reluctant to read and are not yet accustomed to applying mathematical concepts in daily life. These factors significantly contribute to the low numeracy literacy skills among elementary school students.

Addressing these issues requires digital-based learning media that align with modern developments while integrating cultural contexts to facilitate mathematical concept discovery. Previous studies have suggested that incorporating cultural contexts into mathematics learning can strengthen students' ability to apply

mathematical concepts effectively (16, 20, 21). Furthermore, culture-based learning comics have shown potential in achieving educational goals, particularly for elementary school students, who are at the concrete operational stage of cognitive development (13, 15, 22). If learning utilizes digital technology according to students' needs, classroom activities will be more enjoyable and learning will become more varied (23, 24).

Therefore, this study aims to develop a culturally integrated e-comic as a learning medium, focusing on data management topics for fourth-grade elementary school students. Interactive culture-based electronic comics are digital learning media in the form of illustrated stories (comics) presented interactively via electronic devices. They integrate local cultural elements as the context of the story and are specifically designed to stimulate and develop elementary school students' numeracy skills through engaging, contextual, and meaningful learning experiences. The e-comic is designed using Canva and Pixton, featuring engaging visual storytelling and practice exercises to enhance students' numeracy literacy skills. The learning activities emphasize contextual problem-solving relevant to mathematical concepts. It is expected that this medium will increase students' motivation to learn while supporting more effective mathematics education. As a result, mathematics learning will not only become more enjoyable but also help students understand concepts better, making it more relevant to the needs of 21st-century education.

Methodology

This study is development research on learning media using the ADDIE approach, which consists of five stages: Analyze Design, Develop, Implement, and Evaluate. However, as an initial needs analysis, this study only applies the first three stages: Analyze, Design, and Develop.

In the analysis phase, the researchers conducted a qualitative study aimed at deeply understanding the phenomenon, emphasizing data accuracy related to the needs of the product to be developed (25). Data were collected through interviews, observations, and documentation. This method was designed to obtain in-depth information while ensuring data triangulation and validation (26).

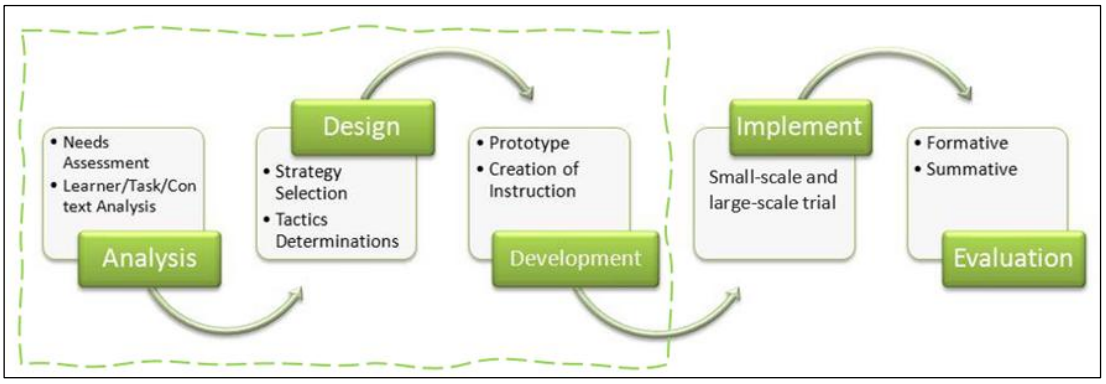

Figure 1: Research Stages using the Addie Method

This research was conducted through a series of stages as shown in Figure 1. The research procedure consists of five main steps: analysis, design, development, implementation, and evaluation (20, 27). However, this study is limited to the first three stages, namely analysis, design, and the development of a prototype product in the form of an E-comic learning medium with a national cultural theme as the context for mathematical problem-solving as well as for the narrative of the comic. The comic is specifically designed to stimulate students' numeracy skills.

In the analysis stage, data were systematically processed and analyzed based on field observations and interviews with 5 teachers and 148 students from 5 different elementary schools in Central Java, Indonesia. The following presents the interview guideline for teachers regarding the need for learning media in elementary mathematics education.

Table 1: Teacher Interview Guide

Aspect	Indicator
Learning Process	- Learning preparation - Learning model - Difficulties encountered in learning - Students' situation during learning - Students' responses during learning - Learning resources - Students' mathematics scores
Use of Learning Media	- Interactive media required by teachers - Facilities and infrastructure
Level of Student Engagement	- Students' interest and involvement in learning
Students' Numeracy Literacy Skills	- Students' understanding - Problem-solving skills - Information analysis skills - Ability to draw conclusions and make decisions

Table 2: Survey Outline for Student Needs

Aspect	Indicator
Mathematics Learning Process	Students' interest in mathematics learning
Availability of Digital Learning Media	Use of learning media; Facilities and infrastructure
Cultural Context	Students' knowledge of Indonesian culture
Numeracy Literacy Skills	Ability to analyze problems; Ability to make decisions and draw conclusions

Below is the interview guide for students regarding the need for media in elementary mathematics education?

Tables 1 and 2 present the aspects and indicators used in interviews with teachers and students to identify media needs based on the current state of mathematics learning in schools. This needs analysis study involved 31 fourth-grade students and 5 teachers from 3 elementary schools in Kudus Regency and 2 elementary schools in Purworejo Regency. These two regencies were selected as subjects because, ethnographically, they exhibit different characteristics—one represents the southern coastal region while the other represents the northern coastal region, which culturally reflects the Javanese context in Indonesia. Before the research was conducted, we first submitted a letter of consent request to the school. Before the data collection, we also provided a verbal explanation in simple and understandable language regarding the purpose and objectives of the study, what participants would be asked to do, and their rights as participants, including the right to refuse or withdraw at any time without any consequences. Observations and interviews were conducted in all 5 schools using pre-designed interview instruments. Subsequently, a needs questionnaire was distributed to the fourth-grade students at these schools. The aim of this activity was to identify the students' needs, the challenges they face, and their characteristics in mathematics learning, particularly in data management. The data collected through interviews and questionnaires were then processed and analyzed to pinpoint the needs and issues that emerge during the mathematics learning process for this topic.

Below is the formula for calculating the needs analysis results and interpreting the findings.

$$Percentage = \frac{(Respondents' Total Score)}{(Maximum Score)} x\ 100\% \qquad [1]$$

Then, the calculation results using equation [1] are interpreted in the following Table 3.

Table 3: Categories of Needs Analysis Results

Percentage	Category
0 – 1.9%	Not needed
2% - 25.9%	A small portion required
26% - 49.9%	Less than half required
50%	Half required
50.1% - 75.9%	More than half required
76% - 99.9%	Majority required
100%	All required

After the descriptive data analysis is completed, the next step is to draw conclusions, conduct an evaluation, and provide recommendations to proceed to the design phase, which will then continue with the product development based on the results of the needs analysis that has been conducted as the initial phase of the overall development process. In the design phase, the product is developed based on the initial idea, which is aligned with the needs of the teachers and students. It is then developed according to the theory of ethno mathematics and media in mathematics education as the theoretical basis for the development of educational products (11, 19, 28). The final stage of this research is the product development, where the product, which has been adjusted to the needs in the field, undergoes both physical and non-physical development, which will then be followed by the assessment of the learning product.

Results and Discussion

The results section describes the findings obtained from your research. Figures are used to present data trends or other visual information while tables are particularly useful when the exact values are important.

This study aims to analyze the need for mathematics learning media on data management material for fourth-grade students in 5 elementary schools in Central Java Province, based on practical criteria for developing learning media. Based on observations conducted in 5 elementary schools across 2 districts, Kudus and Purworejo, it was found that the schools do not have adequate learning media. The available facilities in the schools include classrooms, whiteboards, desks and chairs, and Wi-Fi access with an unstable network. In addition, the schools have LCD projectors and Chrome books, but their utilization has not been optimal. This is due to the procedure requiring prior permission and device setup by the office before they can be used in classroom learning. The following presents the observation results during mathematics lessons (Figure 2 and Figure 3).

Figure 2: Documentation of Observation Activities with Students

The available learning media in schools are still limited and rarely utilized, especially for mathematics learning on data management material. Although the schools have enough Chrome books to support the learning process, their use in the classroom is still very infrequent. Therefore, it is hoped that the use of Chrome books can be optimized through digital learning media, which can support the success and smoothness of the learning process. Technology can be utilized to

develop learning media or facilitate its use. Currently, the use of technology is very important to prepare students to face the changing times. This aligns with the opinion of past researchers (29), which states that technology in education can be used as a system that simplifies and supports the smoothness of the learning process, ensuring that learning objectives are achieved and desired results are obtained.

Figure 3: Documentation of Observation Activities with Teachers

The results of the interview with fourth-grade teachers at the elementary schools revealed that mathematics learning, particularly the material on data management, has been adapted to the Kurikulm Merdeka. In this curriculum, learning is directed to activate students, although its implementation is sometimes not optimal due to the limited time available to transition to the next material. Teachers generally use methods such as lecturing, discussion, and assignments during the learning process. Additionally, the interview results revealed a few needs and issues in mathematics learning. Some students are less interested and even dislike the subject of mathematics. During lessons, students often feel bored, lose focus, and lack concentration, especially because they struggle to understand the material on data management, which requires a deep understanding of concepts and accuracy.

Regarding the use of learning media, the teachers' resources are still very limited, and the types of questions given do not focus on improving students' numeracy literacy. Some students' scores during tests are still low and below the minimum competency standard. To address this issue, teachers form study groups consisting of students with high and low abilities. Students with lower abilities receive additional guidance from the teacher. In mathematics learning, the media used by teachers include books, the internet, and practice questions written on the board to be solved together. However, the teacher has not utilized numeracy literacy-based questions or higher order thinking skills (HOTS) type questions due to time constraints and a lack of understanding of such question types. As an alternative, the teacher usually uses practice questions from books. Students have used Chrome books during lessons, but the use is very rare because teachers have not optimally implemented digital media due to time limitations and a lack of ability in developing digital learning media.

In addition to the interviews and field observations, the results of this needs analysis were strengthened by data from a questionnaire distributed to 148 fourth-grade students at five elementary schools in Kudus and Purworejo, Central Java, Indonesia. The following is a table 4 showing the results of the questionnaire responses.

Table 4: Results of Student Needs Analysis Questionnaire

No	Indicator	Questionnaire Results
1	Student interest in mathematics learning	75%
2	Use of learning media	84%
3	Facilities and infrastructure	52%
4	Student knowledge of Indonesian culture	57%
5	Ability to analyze questions	69%
6	Ability to make decisions and conclusions	68%

The analysis questionnaire was given to students to evaluate the current learning conditions, the availability of learning media, and the students' needs for e-comic-based learning media. This questionnaire uses an even Likert scale with four response options: "Strongly Agree," "Agree," "Disagree," and "Strongly Disagree." The data obtained from the questionnaire were then analyzed quantitatively in the form of percentages. Based on the results of the needs analysis questionnaire, the average percentage score obtained was 67.5%. Referring to the percentage categories modified from Munggaran (2012), where a percentage score of 50.1% - 75.9% indicates that more than half of the students need practical media in the mathematics learning process. This suggests that the designed media can support the enthusiasm of elementary school students, particularly in learning mathematics on data management, with a focus on developing students' numeracy skills. This is in line with research that states that the development of mathematics learning media involving broader contexts can provide a positive potential to enhance students' numeracy skills (8, 30–32). Based on the results of observations, interviews, and student needs questionnaires, it was found that the media used in elementary schools is inadequate. During mathematics lessons, teachers only use books, the internet, and the blackboard. Learning process requires concrete media that serve as tools and infrastructure to facilitate the teaching process (33). In addition, it was found that both students and teachers of fourth-grade elementary schools need media that can address the problems encountered during the learning process. Educational media is a tool used to convey messages with the aim of stimulating the students' thinking, attention, and interest, so that the learning objectives can be achieved effectively (2, 27, 34). Fourth-grade students in Kudus and Purworejo Districts face difficulties in understanding the concepts of data management. The proposed learning media in this study, which is expected to be a solution to this issue, is the e-comic media. The use of e-comic media can stimulate students' enthusiasm and motivation to engage in learning, while also enhancing character education. This aligns with statements that the learning process utilizing e-comic media can help students achieve success in further education (12, 35, 36).

Furthermore, the results of the needs analysis indicate that schools currently require media that can provide positive potential in terms of students' numeracy skills to support the implementation of mathematics lessons in elementary schools. One type of learning media that can provide positive effects on students' numeracy skills is interactive media in the form of mathematics learning comics (12, 36). This highlights the need for efforts to improve numeracy literacy skills, one of which can be achieved through comic media, which can boost students' learning spirit and train numeracy literacy through stories that are relevant to everyday life.

Comics are an effective visual communication medium for delivering information that is easy to understand (13, 31). The low numeracy literacy skills of students cause them to struggle in applying basic mathematical concepts to solve everyday problems. Numeracy literacy is crucial in mathematics because it involves reasoning and critical thinking patterns in addressing challenges faced by learners. Additionally, numeracy literacy helps students understand the role of mathematics in solving practical problems in daily life (7).

Therefore, in efforts to enhance numeracy skills for elementary school students, a relevant learning media will be developed, tailored to the characteristics of elementary students in the form of electronic comics. The context used in solving mathematical problems will incorporate elements of Indonesian cultural heritage. The cultural context provides relevance to the needs, addressing the cultural crisis that is a key concern of educational programs in Indonesia.

Based on the needs analysis, the next step involves designing a learning comic that can be used as a medium for teaching mathematics in grade IV elementary school. The storyline of the comic will incorporate elements of Indonesian cultural heritage as an introduction to the learning process. Technology-based learning media, such as this e-comic, has great potential to capture students' interest in learning, which can gradually enhance their numeracy skills. Below is the design of a culture-themed e-comic aimed at improving numeracy skills among elementary school students.

Figure 4: Display of Electronic Comic Design with Cultural Nuances

In Figure 4, the comic is designed to meet the needs of students, where the storyline is developed based on the experiences and knowledge of the students. The context is drawn from Indonesian culture, including traditional clothing, customs, and regional food. This context serves as an introduction to the learning process, bringing up contextual problems that can be modeled into mathematical problems. This approach aligns with research suggesting that students tend to have a higher level of interest when mathematics is presented in realistic problems (20, 37–40).

Figure 5: Storyline in E-Comics with Cultural Context

The mathematics learning material in grade IV, one of which is Data Presentation, presents a significant challenge for teachers. Teachers find it difficult to provide a context that aligns with the available learning media. The culturally themed e-comic design to improve numeracy skills in elementary school students is a multimedia product developed by considering the material, ease of use, and graphics, making it appealing to grade IV students (Figure 5). This approach is in line with research that states the selection of learning media can enhance student interest, thereby potentially improving learning outcomes significantly (41–43).

Figure 6: Design of Stimulation of Students' Numeracy Abilities

The current learning target is the improvement of students' numeracy skills. Figure 6 illustrates that the stimulation for enhancing numeracy skills is based on the Realistic Mathematics Education

theory. Students are given contextual problems that are relevant to the discovery of mathematical concepts corresponding to the teaching material. Once the concept is understood, students then solve mathematical problems in a broader context. This learning activity is carried out repeatedly, which allows for consistent improvement in numeracy skills. This aligns with research stating that numeracy skills can be enhanced through the provision of contextual problems (10, 15, 44).

Thus, the product in the form of a culture-themed e-comic to enhance elementary school students' numeracy skills has been designed and developed based on a needs analysis that aligns with the mathematics learning in elementary schools. The product will then be further developed and tested on a limited and broader scale for quality improvements, ensuring it meets the criteria of feasibility before being disseminated on a larger scale to elementary schools.

Conclusion

The needs analysis reveals issues in mathematics learning, particularly in the material on data management. Students face difficulties in understanding the concepts being taught due to a lack of interest in learning. The teaching media used by teachers are still limited, such as books, the internet, and blackboards, which do not provide a concrete and interactive learning experience. The empirical results of the needs analysis show an average score of 67.5%, indicating that most students require practical, digital-based learning media to enhance their numeracy literacy skills. Based on these findings, it can be concluded that both students and teachers in elementary schools need relevant learning media, one of which is a culture-themed e-comic that can help improve students' numeracy abilities. Therefore, a culture-themed e-comic has been designed and developed with the potential to positively impact students' numeracy skills. This product can eventually serve as a reference for learning media that can increase student engagement and improve learning outcomes.

Abbreviation

None.

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Author Contributions

Trubus: Study design, data collection, Riawan: Analysis, writing of the manuscript, Jayanti: Study design, data collection, Teguh: Study design, data collection, Suyitno: Analysis, writing of the manuscript, Romellen: Study design, data collection, Ronald: Study design, data collection, data collection, Suripah: Analysis, writing of the manuscript.

Conflict of Interest

The authors have disclosed no conflict of interest.

Ethics Approval

The written informed consent forms were signed by all the subjects participating in the study.

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