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The Use of E-Comics Based on A Realistic Mathematical Approach to Improve Critical and Creative Thinking Skills of Elementary School Students

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ABSTRACT

Objective: In the 21st century, critical and creative thinking skills must be nurtured and grown from elementary school. The way to improve this ability can be done by utilizing Mathematics subjects but with a realistic approach that allows students to immediately learn critically and creatively according to the context of everyday life so that students can think organized and creatively in their lives, not limited to subjects. One way to facilitate the learning objectives of Mathematics with a Realistic Approach is to utilize e-comic learning media that allows students to see the context of the lesson using their visual abilities. **Method:** This research uses literature studies by searching relevant journals, books, and articles using the Publish or Perish application. **Results:** The study showed that e-comics improved students' critical thinking skills and creativity. In addition, researchers also found that several factors make mathematics learning with a realistic approach that utilizes e-comics efficient, as well as steps to conduct mathematics learning with a realistic approach that utilizes e-comic learning media. **Novelty:** This research uses an innovative and creative approach to improving students' critical and creative thinking skills through Mathematics learning using e-comic learning media.

INTRODUCTION

One of the main challenges in Indonesian education in the 21st century is to create a young generation who are always ready, have skills, and can think logically and critically when facing various competitions and challenges in the global society. Paying particular attention to students' learning and mathematical abilities in this era is necessary to achieve this goal. The main focus is the application of mathematical knowledge to overcome problems that arise in the surrounding environment or everyday life (Harmini et al., 2020). Learning mathematics in the 21st century requires the integration of critical, collaborative, communication, and creative skills characteristics. In this context, these characteristics include essential competencies that are the foundation for achieving mathematical literacy skills (Janah et al., 2019; Salim, 2019).

The implementation of mathematics learning still faces several challenges. The learning process is often constrained by conventional methods that tend to be monotonous, as well as the need for more variety and creative use of learning media. These constraints can affect students' perceptions of mathematics learning, leading to the assumption that learning is difficult and tedious. These problems are caused mainly by the learning process in schools that still use conventional methods. This assumption can potentially reduce student learning motivation, affecting learning outcomes (Siregar et al., 2020).

The step that teachers can take to make students have strong mathematical knowledge is to carry out Realistic Mathematics Education (RME), which allows students to understand contextual learning. RME will make students learn critically by learning mathematics using constructive activities and phenomena that exist in everyday life (Purba, 2022). The ability to think critically is trained with the existence of mathematics is needed in the current era where humans will have many choices and problems in their lives ranging from personal choices and problems to the scope of groups, regions/regions to the national and international scope because of the disclosure of information. In addition, RME will make students more creative in solving problems. The problems presented by RME will help students understand the content of the context of the problem because it is close to everyday life. Through the Realistic Mathematics approach, students will analyze and find solutions based on their creativity and genuine experience (Altan & Tan, 2021; Kardoyo et al., 2020; Simanjuntak et al., 2021; Son & Fatimah, 2020; Yayuk et al., 2020). By studying mathematics, students will have the ability to think critically, which is characterized by several characteristics they have, such as (1) being able to reason, (2) being able to make the right decisions in solving problems, (3) being able to analyze, organize, and extract information from existing facts, (4) being able to make conclusions, solutions and appropriate arguments (Kurniawati & Ekayanti, 2020; Suci et al., 2019)

One of the learning media that can be used to learn mathematics, especially in realistic mathematics, is an e-comic. E-comic is one of the learning media chosen because it can take advantage of students' penchant for reading picture books to convey material better. Using internet-based comics can help students understand the context of the problems raised (Matuk et al., 2021; Şahin & Kara, 2022; Septianita et al., 2023). E-comics with learning that can be combined with visuals and stories can make it easier for students to understand the context of math problems in everyday life. Based on research by Siregar et al. (2020), learning mathematics using E-comics, mathematics learning will be more effective. Research by Coal et al. (2021) also shows that e-comics can improve students' ability to understand the context of mathematical problems better. Meanwhile, research by Harmini et al. (2020) showed that mathematics comics have the potential to impact students' mathematical literacy skills positively. Developing e-comic media can be used to improve mathematical problem-solving skills (Kristianto & Rahayu, 2020).

Based on previous research, researchers consider the need for further research on developing e-comics to improve elementary school students' critical and creative thinking skills. The decision to analyze e-comics as a learning medium is based on the high interest of learners in reading comics or illustrated books, which can awaken their imagination and creative thinking. Thus, independent learning media must be developed to make the learning process more exciting and interactive. Therefore, the author is interested in conducting research using mathematics learning media. This research is expected to overcome boredom and boredom that learners may experience during the learning process. The use of this learning media is expected to provide a more dynamic and exciting learning experience so that students can be more involved and enthusiastic in learning mathematics (Akmalia et al., 2021; Fatra et al., 2023; Georgiou & Ioannou, 2021; Haleem et al., 2022; Lutfi & Hidayah, 2021). In addition, this research is expected to positively contribute to the effectiveness of mathematics learning and motivate learners to develop their mathematical skills better. Therefore, researchers

intend to research the use of e-comics in realistic mathematics learning to improve students' critical thinking skills and creativity.

RESEARCH METHOD

This research was conducted using literature studies. A literature study studies a phenomenon by collecting relevant written and electronic information (Prihatinia & Zainil, 2020). The data used in this study was taken from the Google Scholar site with the help of the Publish or Perish Harzing application with a time range of 2018-2023. The journals collected will be studied and understood by researchers to conclude. The implementation of literature studies carried out by researchers uses steps such as (1) Determination of research questions, (2) Literature search, (3) Literature selection, (4) Evaluation of literature quality, (5) Data extraction, (6) Analysis and synthetic data and in the last step carried out (7) Conclusion Making based on the literature that the researcher has read.

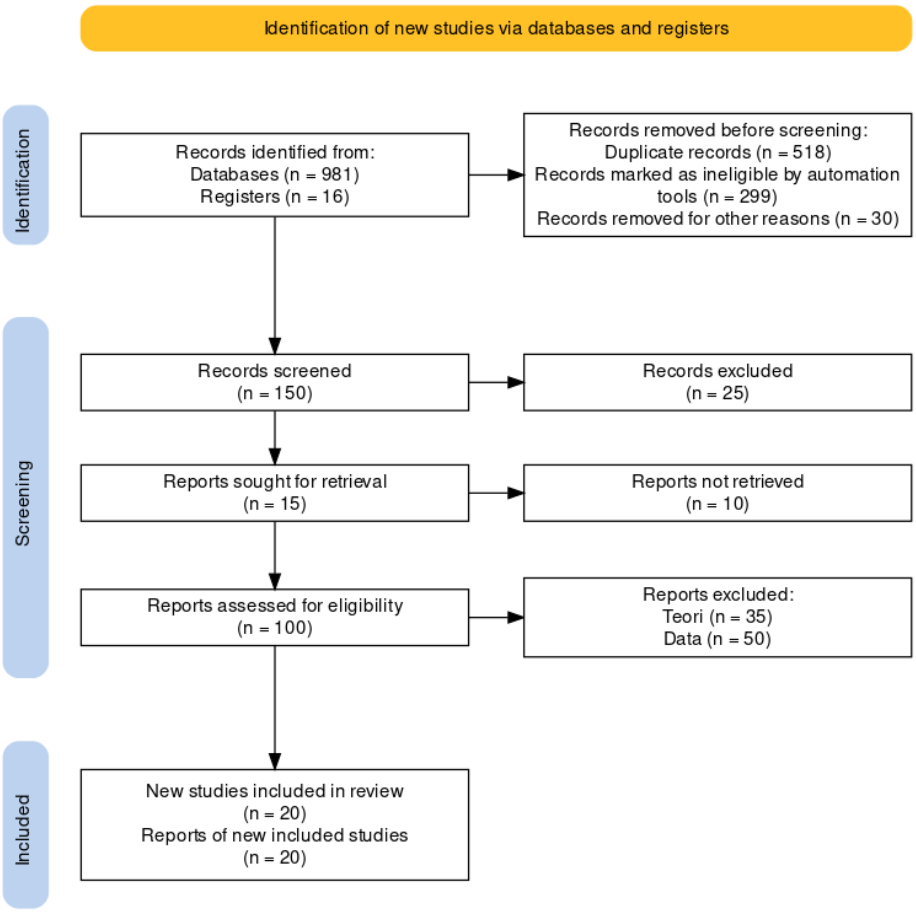

Figure 1. Literature review flow.

At the identification stage, it was determined that the database used was Google Scholar. The strings used in the first search were E-Comics, Realistic Mathematical Approach, and Critical And Creative Thinking Skills. Search results based on the entered string reached 981 according to the research topic. The screening results identified 150 articles that fit the criteria, while 25 articles were not included in the next stage. Therefore, a total of 100 articles are considered for future use. Data is

differentiated into clusters of techniques in data mining, and in this process, as many as 19 articles are used.

RESULTS AND DISCUSSION

Results

The results of the literature review displayed based on searches through Publish or Perish with keywords E-Comic, Realistic Mathematical Approach, Critical and Creative Thinking Skills, and Elementary School Students can be seen in Table 1.

Table 1. The journal results in the literature review.

No	Authors	Title	Literature review results
1	(Rahmasantika & Suparman, 2020)	E-Math Comic Needs Analysis to Stimulate Critical Thinking Skills	Research analysis with descriptive qualitative methods shows that the use of e-comics can stimulate students' critical thinking skills
2	(Nurmayani & Sinaga, 2023)	Development of E-Comic-Based Learning Media Using Pixton in Theme 7 Sub-theme 2 in Class V Elementary School 101775 Sampali FY 2022/2023	Based on this research using experimental methods, it was found that using e-comics in mathematics learning can improve students' analytical skills in solving problems in everyday life.
3	(Widyasari & Nurcahyani, 2021)	Development of E-Comic-Based Mathematics Teaching Materials on the Topic of Multiplication and Division with Realistic Mathematics Education (RME) Approach	Based on this research analyzed using Hannafin and Peck's analysis, it can be concluded that e-comics on RME can improve students' mathematical skills and increase students' creativity with the visuals presented
4	(Arliani & Khabibah, 2022)	Development Of Mathematical Digital Comics With Ethnomathematics Approach For Grade Iii Elementary School On The Material Of Weight Unit Conversion	Analysis using the ADDIE method in this study shows that integrated e-comics can improve students' thinking skills and creativity, especially in problem-solving
5	(Aprilia et al., 2023)	Development of Probability Learning Media PjBL-STEM Based Using E-comic to Improve Students' Literacy Numeracy Skills	Based on the results of research using research and development methods, it was found that the use of e-comics can improve students' critical thinking skills through mathematics learning

No	Authors	Title	Literature review results
6	(Darmayanti &; Sugianto, 2022)	Digital comic learning media based on character values on students' critical thinking in solving mathematical problems regarding learning styles.	This study used quantitative analysis and found that Digital Comics were able to improve students' problem-solving skills significantly.
7	(Subroto et al., 2020)	The Effectiveness of Using Comics as a Mathematics Learning Media	Based on analysis with quantitative methods in this study, it was found that the use of mathematics comics as a learning medium has a positive correlation with students' motivation and mathematics learning outcomes
8	(Suri et al., 2022)	Improving mathematic communication ability through Islamic math e-comic media	Based on research using the ADDIE research model, it was found that the use of e-comics was able to increase students' critical ability to build space
9	(Nalurita et al., 2019)	Optimization of Mathematical Problem Solving in E-Comic Math-Assisted Problem Based Learning (PBL)	Analysis of the literature review used in this study shows that the approach to learning mathematics by utilizing digital comic media can improve student understanding and students' critical thinking than classes with conventional learning methods
10	(Fitriyani et al., 2021)	Application of comic media to improve literacy skills in understanding math story problems in elementary schools	Research on the effectiveness of using comic media with quantitative methods shows that mathematical comic media can improve students' ability to understand material, especially in story problems that have the context of everyday life.
11	(Praniadani, 2019)	The Effect of the Realistic Mathematics Education (RME) Learning Approach Assisted by Fun And Easy Math Comic Media on Mathematics IV Learning Outcomes at State Elementary School Gunungpring 2 Muntilan, Magelang Regency)	Based on research using quantitative analysis shows that the use of e-comics in RME can improve students' ability to understand mathematical problems in everyday life.
12	(Rahmata, 2021)	Development of mathematics e-comics based on	Research using the ADDIE development model shows that RME using e-comics is effective in teaching and learning

No	Authors	Title	Literature review results
		realistic mathematics education (RME) containing ethnomathematics social arithmetic material	activities.
13	(Soleh & Agustin, 2020)	Development of E-Comic as a Learning Media for Grade IV Elementary School Mathematics on Fractional Material	Using research and development research methods, it was found that using e-comics for mathematics learning media is included in the feasible category because it can improve students' thinking skills.
14	(Toraya, 2019)	Development of Mathematics Comics Characterized by Realistic Mathematics Education (RME) to Understand the Concept of Social Arithmetic	Research using research and development methods shows that mathematical e-comics can increase students' problem-solving creativity.
15	(Nisa, 2022)	Development of E-Comic Media-Based Problems in Mathematics Subjects Class IV ES Turirejo 1	In the results of quantitative analysis in this study, it was found that E-Comic Media based on problem-focused teaching was able to affect students' mathematical abilities significantly.
16	(Siregar et al., 2020)	Development of e-comic learning media in mathematics learning	The results of research using research and development methods found that e-comics increase students' motivation and ability to think structured through mathematics learning.
17	(Kristianto & Rahayu, 2020)	Development of E-Comics Learning Media to Improve Grade IV Mathematics Problem Solving Skills	Research with this research and development method shows that developing e-comic media can improve student problem-solving in mathematics learning.
18	(Harmini et al., 2020)	The Potential of Mathematics Comics to Develop Mathematical Literacy	Based on the results of the analysis with literature studies, it was concluded that Mathematics Comics can improve students' mathematical abilities, especially on problems or explanations that have the context of everyday life.
19	(Sipayung et al., 2021)	The Differences in Students' Creative Problem-Solving Ability with and without Realistic	Research using this experimental model found that video-based e-comics can increase students' problem-solving creativity.

No	Authors	Title	Literature review results
		Mathematics Comic Video	

Discussion

Based on the results of the analysis of articles that have been collected and studied in depth by researchers, it was found that there is an influence on the use of e-comics in mathematics learning, especially in realistic mathematical approaches, able to improve students' critical thinking skills and ability in creativity. E-comic-based learning media using Pixton is declared feasible, practical, and effective to be applied in school learning (Nurmayani & Sinaga, 2023). E-comic-based mathematics learning materials are very valid and respond with high criteria so that the media developed by researchers can be used as additional teaching materials to teach multiplication and division concepts (Widyasari & Nurcahyani, 2021). The research results found that the most significant influence of e-comics on improving critical and creative thinking skills lies in the presentation of mathematics teaching through comics. Presenting through visuals with comics is a suitable method for students because students at elementary school age often use visuals. However, it does not rule out the possibility that there are students who are more dominant in using the other five senses. Therefore, this digital comic media can help and facilitate the learning process. This media can be used as an alternative for teachers in developing materials and media for other learning materials (Darmayanti & Sugianto, 2022).

In critical thinking, students can use the context of stories in e-comics close to everyday life. E-comic media can drive student motivation in learning mathematics because students are given examples of the application of mathematics in everyday life. The material learned does not feel 'foreign' to students because the context is taken from around students and can be found in everyday life (Arliani & Khabibah, 2022). Teachers can help students understand the context by provoking their logic by using what if so that students can imagine the context more optimally. To provoke students to think critically, teachers can also use open-ended questions so that students can think more deeply about learning mathematics using the context of everyday life. Finally, teachers should also provide space for students to ask questions when confused with the context of the comic. According to a review of the literature researchers have reviewed, the steps teachers must take to teach creative thinking are similar to the way to think critically. Teachers should also have discussions in class to discuss the context previously given with digital comics (Ahsanah & Utomo, 2020; İlhan et al., 2021; Linardatos & Apostolou, 2023; Pratiwi & Palupi, 2022; Rutta et al., 2021).

Based on the study above, it should be underlined that although e-comics can improve students' critical abilities and creativity, the role of teachers remains crucial. In carrying out RME learning and with e-comic media, teachers are expected to be able to present exciting pictures and cases that are close to students and appropriate language. If one of these aspects cannot be fulfilled, the potential for learning mathematics with a realistic approach that utilizes e-comics can run optimally can go down. Meanwhile, other factors need to be underlined to make realistic mathematics learning with e-comics run optimally, as revealed by research results from Widyasari & Nurcahyani (2021), E-Comic-based learning materials that are developed still have limitations both in design and subject matter, it is hoped that future research can develop products in

the form of E-Comics that are more attractive in terms of design and material More varied lessons. In the implementation of E-Comic-based mathematics learning materials for parents and teachers, it is hoped that there will be assistance for students so that the use of media runs effectively (Maulidya & Ambarwati, 2022; Pramasdyahsari et al., 2023; Sabon et al., 2022; Widyasari & Nurcahyani, 2021; Wolff et al., 2023). Suggestions from researchers for future research as the results of research from Suri et al. (2022) researchers are expected to develop Mathematics E-Comic media to be better in order to achieve a high level of media effectiveness with good criteria and worthy of being disseminated as an innovation in mathematics learning media. It aims to increase learners' attractiveness and their activeness in learning. Thus, the learning process can occur optimally (Budinurani & Jusra, 2020).

E-comic

E-comic is a learning media developed to support learning in education by presenting learning as digital comics (Wicaksana et al., 2020). E-comics will package the learning taught by the teacher in attractive visuals with a storyline previously conceptualized by the teacher or educators. One application that can be used to create e-comics is Comic Life 3 (Rina et al., 2021). Comics are considered a unique teaching material, which combines text and images in a creative form. This creative nature allows comics to be a medium capable of attracting the attention of people of different ages, especially children. Comics are considered a unique teaching material, which combines text and images in a creative form. This creative nature allows comics to become a medium that can attract the attention of people of various ages, especially children.

E-comic math is a teaching material with a format similar to comics, with educational elements that include mathematical material adapted to environmental conditions and student needs (Nalurita et al., 2019). Using comic media in the learning process can generate new desires and interests, increase motivation, stimulate learning activities, and have a positive psychological effect on students. The use of comics can challenge students to complete assignments and encourage the use of critical thinking skills when analyzing stories and art elements in comics (Abrori et al., 2023; Calafato & Gudim, 2022; Dallacqua, 2020; Mamolo, 2022; Pantaleo, 2022). E-Comic Math, as an electronic teaching material, can be used as a learning resource in the classroom or for students' independent learning. This differs from conventional companion teaching materials that are often too long and use a high level of language, which can make students feel bored. Today, students need teaching materials that present the material and are accompanied by relevant examples corresponding to the subject matter. Therefore, using E-Comic Math can increase students' reluctance to read and encourage them to enjoy and perceive the subject.

Realistic Mathematics

The Realistic Mathematics Education Approach is a method of learning mathematics that utilizes realistic problems or actual circumstances in the learning process. This approach is designed so that each learner can experience rewarding experiences related to the context of their daily lives. The Realistic Mathematics Education approach aims to make a concrete contribution to the understanding and application of mathematical concepts in real-world situations. Realistic mathematics is an approach to learning mathematics that uses real problems in everyday life by developing skills in learning mathematics, conducting discussions and collaborations, facilitating interactive

communication between students, and conducting experiments individually and in groups (Jeheman et al., 2019).

The Realistic Mathematics Education approach has a core concept that focuses on the meaning so that students can more readily accept and understand the learning process. In this approach, learning is directed to have significant meaning for learners. In addition, the Realistic Mathematics Education Approach provides opportunities for students to play an active role in the learning process. In contrast, the role of teachers is more prominent in motivating and encouraging student involvement in learning activities (Bhoke, 2019). This approach also emphasizes solving mathematical problems in the form of stories related to everyday life or according to learners' level of knowledge. Through intense practice, students can better understand mathematics learning material through a Realistic Mathematics Education Approach (Armiyanti, 2019). In mathematics education, the merging of mathematical concepts with real life, known as RME, has become the subject of study (Lestari & Ekawati, 2019). RME carries characteristics that emphasize human activities as a bridge to build mathematical concepts, by the nature of comics that can present stories with intentions and objectives that can be adapted to the creations of comic creators.

The steps in implementing the Realistic Mathematics Education Approach, according to (Shoimin, 2016) include:

1. Teachers provide contextual problems or problems to students.
2. Students solve problems or contextual problems that have been given.
3. Learners discuss and compare the answers they get with their classmates.
4. Students make conclusions from the results of the answers they have obtained.

Research conducted by Handayani (2020) applies the steps of the Realistic Mathematics Education Approach as follows:

1. Learners solve problems according to their respective abilities.
2. In solving problems, learners can use their reasoning.
3. After the learners solve the problem, they present the result or answer to the class.
4. Learners confidently convey their results and politely comment on their peers' results.
5. Learners are given the freedom to choose how to solve a given problem.

From the above steps, a realistic mathematical approach involves critical steps such as providing contextual problems, individual solving by learners, joint discussion, and conclusion-making. In its implementation, students are free to use their reasoning and are welcome to deliver the results in front of the class. This approach focuses on learning mathematics and develops students' critical thinking and social skills.

Mathematical Critical Thinking

The ability to think critically in the context of mathematics learning involves a cognitive process that aims to understand mathematical concepts based on mathematical reasoning. The development of critical thinking skills can be done through discussion activities between students, where the role of the teacher is vital in encouraging students to activate their critical thinking skills in the classroom (Alsaleh, 2020; Amin et al., 2020; Tang et al., 2020; Wale & Bishaw, 2020; Yu et al., 2020). This effort is expected to produce optimal critical thinking outputs, which include students' ability to solve problems, make decisions, and understand new mathematical concepts. In increasing

the potential of these outcomes, cognitive strategies can be used to stimulate critical thinking skills.

As explained by Rahmasantika and Suparman (2020), critical thinking indicators become important guidelines for researchers in carrying out this research. These indicators involve students' ability to identify facts clearly and logically, formulate main problems accurately, apply learned methods accurately, express data/definitions/theorems in solving problems appropriately, make decisions and execute them correctly, evaluate relevant arguments carefully, and be able to distinguish between valid and invalid conclusions. This mathematical critical thinking ability will function so that individuals can analyze, evaluate, and draw conclusions in a world that is increasingly complex, rapidly changing, and challenging to predict in order to maintain their lives (Janah et al., 2019).

Creative Thinking

Creative thinking is an individual ability to produce a new idea in a place or group in a specific region (Anditiasari et al., 2021). Creative thinking is at a higher level than critical thinking because an individual must think critically first to think creatively. Creative thinking is also divergent thinking, where one will find original, aesthetic, and constructive thoughts related to the views and concepts of the individual, and is often synonymous with divergent thinking. Creative thinking indicators involve the ability to think fluently by producing relevant ideas and smooth flow of thought, flexibility in changing ways or approaches and thinking in different directions, authenticity in providing unusual and unique answers, and detailed thinking by developing, adding, and detailing the details of an idea (Anditiasari et al., 2021b). Overall, research and literature show that applying scientific approaches using comic media has a positive impact on improving students' creative thinking skills. A study by Aulia et al. (2020) confirms that using comics in learning can effectively increase students' science literacy. Other studies, such as those conducted by Zarvianti and Sahida (2020), show that problem-based comic development can improve students' creative thinking skills. In addition, the development of comics packaged in grammatic books has also been proven to improve the creative thinking skills of grade IV elementary school students (Risma et al., 2022). Thus, using comics as a learning medium can be considered an effective strategy to improve students' creative thinking skills at various levels of education (Lisnani et al., 2023).

Based on research conducted by Habibah et al. (2021), it was found that the use of learning media has a positive impact on stimulating learners' thoughts, feelings, attention, and interests. This contributes to the effectiveness of the learning process. In addition, using learning media can also stimulate students' thinking skills in solving problems, as supported by research by Sanusi et al. (2020), which shows that using Android-based educational game learning media can improve students' problem-solving and creative thinking skills. The use of learning media not only provides a positive stimulus to the learning process but can increase student enthusiasm in facing and solving problems, especially in mathematics lessons (BatuBara et al., 2021).

CONCLUSION

Fundamental Finding: E-comics as a learning medium is adequate because it can improve elementary school students' critical and creative thinking skills by presenting mathematical concepts in everyday life**. Implication:** E-comics are effective as a

medium for learning Mathematics by presenting concepts in everyday life. However, its success depends on the teacher's ability to provide stimulus, and the lack of stimulus can reduce the efficiency of using e-comic. Therefore, teachers need guidelines and training to increase the effectiveness of e-comics in realistic mathematics learning in Primary Schools in the hope of increasing student attraction and positive contributions to mathematics understanding and skills. **Limitation:** The study highlights several limitations. First, the effectiveness of e-comics depends on the teacher's ability to provide stimulus. Second, the study did not detail the types of effective stimuli or guide teacher administration of stimulus. Third, e-comics attract attention but need to balance with the teacher's stimulus. Fourth, the stages of learning design with e-comics need to be explained in depth. Fifth, there needs to be an analysis of the long-term impact of using e-comic. Lastly, a focus on mathematics may limit the generalization of findings to other subjects, and the applicability of the results in different learning contexts needs to be discussed. **Future Research:** Subsequent research focused on increasing the effectiveness of e-comics in Mathematics learning in elementary schools. The plan involves field research, diversification of e-comic content, and understanding students' learning motivations. Practical guidelines for teachers, the study of parental perception, and the development of interactive platforms are also progressive. Contextual and cultural factors will be considered, which are expected to provide deep insights to improve the approach to learning mathematics with e-comics at the elementary school level.

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