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Realizing the character of environmental care through the use of interactive e-comics based on natural disaster mitigation (KOMINA)

Tuti Mutia [1]* , Alfi Sahrina [1] , Adip Wahyudi [1] , Putri Mahanani [2] , Ease Arent [3] , Novika Adi Wibowo [1] , Ravinesh Rohit Prasad [4]

[1] Department of Geography, Faculty of Social Sciences, Universitas Negeri Malang, Malang, INDONESIA
[2] Department of Education, Faculty of Education, Universitas Negeri Malang, Malang, INDONESIA
[3] Department of Geography, Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, Makassar, INDONESIA
[4] Department of Social Sciences, School of Arts and Humanities, Fiji National University, Suva, FIJI
*Corresponding Author: tuti.mutia.fis@um.ac.id

ARTICLE INFO	ABSTRACT
	Environmental damage has triggered various natural disasters and has now become a serious global concern. To address this, it's important to build environmental awareness from an early stage. One way to do this is through disaster mitigation-based e-comics (KOMINA), which are designed to be interactive and contextual. KOMINA presents natural phenomena in an engaging way and includes real-life examples that help learners connect the content to their everyday lives. The purpose of this study was to determine the significant effect of natural disaster mitigation e-comics on students' environmental awareness attitudes. This study used a quasi-experimental method with a post-test only control group design. The research was carried out at the Laboratory Elementary School at the State University of Malang, involving a total of 61 fifth-grade students from two parallel classes. Class VA, consisting of 30 students, served as the experimental group, while class VB, consisting of 31 students, served as the control group. The questionnaire given at the end of the learning process served as a research instrument to obtain the final data. Data were analyzed using inferential statistics with a t-test. The t-test results served significance value of $0.000 \leq 0.05$, indicating a significant difference between the two groups. The average post-test score of the experimental class was 84.5, while the control class scored 74.5. These findings highlight the important role of disaster mitigation e-comics in fostering students' environmental awareness and caring attitudes. Through KOMINA, students are encouraged to actively engage with natural phenomena presented in the e-comics, making the learning process more meaningful and impactful.. **Keywords:** e-comics, disaster mitigation, environmental care

INTRODUCTION

Every child is born with unique potential. However, this potential needs to be nurtured and strengthened through proper guidance and meaningful social interaction. With the right support, children can grow and develop their character to reach the fullest expression of their abilities (Junaedi et al., 2021). Character education in schools plays a crucial role in shaping a child's personality, it needs to be carried out in a structured and well-planned way so that students' potential can grow and develop to the fullest (McBride et al., 2013). Ultimately, the aim is to nurture individuals who have positive impact on both them and their surroundings. But conventional approaches have not touched the affective aspects of students in depth, especially in shaping the character of concern for the

environment. Amid growing concerns over environmental damage, there is a need for innovative learning media such as disaster mitigation based interactive e-comics that can effectively convey character values in a visual, contextual, and engaging way. In Indonesia, character education can be strengthened through learning activities that integrate and reflect the values of Pancasila, making them more relatable and meaningful for students. Character education that incorporates Pancasila values emphasizes the development of essential moral and social qualities in students. These include religious values, mutual respect, discipline, honesty, independence, hard work, creativity, nationalism, curiosity, democracy, patriotism, appreciation for achievement, good communication, love of peace, love of reading, environmental awareness, social concern, and a strong sense of responsibility (Ramadhan et al., 2024).

Building a strong sense of environmental awareness in students is essential because the environment directly impacts human life and well-being (Aquan et al., 2025). Positive environmental attitudes and actions reflect both preventive and corrective efforts to protect nature and reduce environmental damage (Wibowo et al., 2023). A lack of concern for the environment can lead to serious issues, such as the degradation of green spaces and a decline in quality of life. Environmental awareness reflects students' sensitivity and sense of responsibility toward their surroundings (Arent et al., 2020; Kurniawan et al., 2024; Millaku et al., 2023; Wibowo et al., 2023). To address this, character education can be integrated into the learning curriculum, allowing schools to instill values and shape positive behaviors as part of the educational process (Diputera et al., 2022; Huang & Hsin, 2023; Ismail, 2021).

In today's world, strengthening students' environmental awareness must go hand in hand with advancing their technological skills, especially within the learning process. It's not enough for students to simply understand ecological issues they also need to develop technological literacy that empowers them to take real, practical actions in support of sustainability. In learning, technology can be used to strengthen students' understanding of environmental issues through the use of interactive digital media, such as climate change simulations, educational videos, and ecology-based e-learning modules. In the era of Industry 4.0, integrating technology into the learning process is no longer optional it's essential (Bergdahl et al., 2020; Küsel et al., 2020; Majeed & ALRikabi, 2022; Mystakidis et al., 2021). Well-designed digital learning media that incorporate environmental themes can effectively help build and strengthen students' environmental awareness and sense of responsibility (Chang et al., 2021; Fahreza et al., 2022).

The use of engaging learning media that integrates environmental themes can boost students' active participation and strengthen their environmental awareness (Aquan et al., 2025; Yunesa, 2019). One innovative example is E-KOMINA, an e-comic based on disaster mitigation. This digital medium doesn't just present information in a visually appealing way it also helps build students' critical understanding of disaster risks and highlights the importance of protecting and preserving the environment.

E-comics make it possible to combine educational content with character values while encouraging students to actively engage in understanding and responding to disaster issues in a way that feels real and relevant to their lives. Through a communicative and technology-driven approach, e-comics serve as an effective tool for shaping a generation of learners who are not only disaster-aware but also deeply care about protecting the environment. This medium can be further developed to help strengthen students' environmental awareness and sense of responsibility (Nazhiroh et al., 2021).

As a learning tool, e-comics offer many advantages: they are cost-effective, durable, interactive, dynamic, and easy to access. Their engaging visuals also make learning more enjoyable and can significantly boost students' interest and motivation to learn (Ranting & Citra Wibawa, 2022).

Today, one of the persistent challenges in education is building strong environmental awareness and responsibility among students. Many still lack understanding and consistent habits when it comes to simple but crucial actions like throwing trash in the right place, sorting waste, and practicing recycling (Daesusi & Asy'ari, 2019; Misiaszek, 2020). These issues are often linked to environmental conditions as well as the limited implementation of environmental education in schools (Kioupi & Voulvoulis, 2019; Misiaszek, 2020). The content of environmental education is not an important subject and is implicitly included so that the goals of environmental learning in Indonesia cannot be clearly identified (Parker, 2018). Therefore, e-comics can serve as an innovative digital learning medium to help strengthen students' environmental awareness and sense of responsibility. The use of e-comics is also an interesting area of study, as it offers new ways to make learning more engaging and meaningful (Daesusi & Asy'ari, 2019; Misiaszek, 2020). Several previous studies have explored the use of e-comics in education. For instance, Fahreza et al. (2022) developed e-comic learning media for mathematics instruction in elementary schools, demonstrating its potential to make lessons more interactive and enjoyable for students. Other research proves that e-comics can improve learning outcomes and creative thinking skills (Hobri et al., 2021). Furthermore, research from Endiawan et al. (2021) outlines the development of e-comics to support learning.

Several previous studies have highlighted the potential of e-comics as an engaging and interactive learning medium. Research shows that e-comics can boost students' motivation to learn, make lessons more visually appealing, and help them better understand academic concepts through clear and structured storytelling (Benardi et al., 2023). This medium has proven effective in delivering learning materials through a communicative and relatable approach, making it well-suited for today's digital generation. However, most existing studies have focused primarily on cognitive and affective aspects of learning, rather than explicitly emphasizing character development, especially in terms of environmental responsibility. In reality, today's educational challenges call for more than just knowledge transfer. There is a growing need to integrate ecosystem values and ecological awareness into learning experiences so that education not only informs but also shapes students into individuals who care about and act for the environment. Only a few studies have specifically focused on developing and testing interactive e-comics with disaster mitigation content as a tool for fostering environmental values. In fact, disaster mitigation is a crucial issue, especially in disaster-prone countries like Indonesia, where students need to build both awareness and preparedness. This lack of research highlights an important gap: how visual media like e-comics can be used not just as learning aids but also as powerful tools for contextual and innovative character building. Therefore, this study seeks to explore in depth the impact of natural disaster mitigation e-comics (E-KOMINA) on students' environmental awareness. The findings are expected to contribute to the development of more meaningful learning media that support character education and environmental sustainability.

Figure 1. Home page view (Source: Authors' own elaboration)

METHOD

This research method is a quasi-experiment with a quantitative approach to measure how effective KOMINA is in influencing students' concern for the environment. E-KOMINA is an interactive e-comic based on disaster mitigation in the form of an electronic book packaged in pdf with the name "KOMINA (Natural Disaster Mitigation Comics)". Learning with fitur. A book cover with cartoon characters. Description automatically generated. The image of the initial menu display can be seen in **Figure 1**.

KOMINA is also equipped with reinforcement and Quiziz at the end of each natural disaster. This natural disaster mitigation-based e-comic is also equipped with instructions for use, explanations from the characters involved in the story. In the instructions for use, options are provided that are equipped with the meaning of the image tools. Quiziz on KOMINA uses quizzes which contains 5 questions in each of the materials and is given a time limit and automatically displays the score. Students also directly interact with these e-comics. Students can find out the correct and incorrect answers directly.

The content of the KOMINA e-comic is structured narratively, divided into three main disaster mitigation series, preceded by an introduction and concluded with a glossary, as shown in the **Table 1**.

Based on the KOMINA e-comic content structure, it can be concluded that the e-comic's learning flow is designed to be **modular and comprehensive**. The main material is divided into three specific disaster mitigation series–flood, landslide, and volcanic eruption–with each series structured to cover a holistic understanding ranging from **causes and prevention to the actions required** during and after the disaster. Furthermore, the e-comic strategically integrates **interactive and self-assessment** elements by including external quiz links directly at the end of each topic series, prompting readers to immediately test their comprehension of the newly learned material. This structure is supported by an initial section for foundational knowledge (mitigation definition) and a final section (glossary) to clarify technical terms, ensuring readers gain a complete and well-structured understanding.

Regarding its **interactive features**, the KOMINA e-comic is designed to enhance user engagement beyond static reading. Navigation is facilitated by **advanced navigation** buttons, including the 'R' (right arrow) for next page, 'MA' (left arrow) for previous page, and a 'NE' (home icon) to return to the series list. For **information enhancement**, users can **click on blue-colored text** within the narrative to reveal or display additional, supplementary information in a pop-up or tooltip style. Finally, the comic utilizes **external multimedia links** for enriched learning, integrating a feature to watch related videos (such as on waste recycling) within the narrative and using "AYO MENONTON!" calls-to-action to lead users to external quiz links for immediate assessment.

This research used a post-test-only control group design, where data were collected once after the treatment was administered to both the experimental and control groups. The study was conducted at the Laboratory Elementary School, State University of Malang, involving 61 fifth-grade students in two parallel classes. Participants were selected using a purposive sampling technique, considering similarities in academic ability based on class average scores. Class VA, consisting of 30 students with an average score of 76, was designated as the experimental group, while class VB, consisting of 31 students with an average score of 75, was designated as the control group.

Table 1. KOMINA e-comic content structure

Order	Content section	Page range
I. Introduction and basics	Pages 1-9	Covers the title page, editorial team, table of contents, usage instructions, character introduction, and the basic definition of **"what is disaster mitigation?"**
II. A. Series 1: Flood	Pages 10-13	Presents the narrative on causes, prevention (waste management, recycling), and actions during/after a flood.
II. B. Flood quiz	Page 14	External link to complete practice questions/a quiz on flood mitigation.
III. A. Series 2: Landslide	Pages 15-19	Presents the narrative on definition, causes, prevention (planting trees), and actions during a landslide.
III. B. Landslide quiz	Page 20	External link to complete practice questions/a quiz on landslide mitigation.
IV. A. Series 3: Volcanic eruption	Pages 21-27	Presents the narrative on warning signs, dangers, and mitigation steps (before, during, and after) a volcanic eruption.
IV. B. Volcanic eruption quiz	Page 28	External link to complete practice questions/a quiz on volcanic eruption mitigation.
V. Glossary	Pages 29-34	Contains definitions of key terms used in the comic (e.g., waste recycling, magma, lahar, disaster standby bag).

Table 2. Questionnaire grid

Indicator	Statement
Always keep the classroom clean	Cleaning the classroom according to daily picket
	Picket the class without being asked by the teacher
	Do not keep or throw garbage in drawers/benches
	Organizing the classroom reading corner after being used for KBM
	Helped wipe the blackboard without being asked
Love the neatness and cleanliness of the environment	No scrawling on walls or desks
	Does not dirty the table
Wise use of natural resources	Save electrical energy as needed (turn off the light switch in the classroom)
	Using water as needed
	Flushing the toilet after defecation or urination
Support the greening of the school	Participate in maintaining the school garden
	Bringing different types of plants
	Participate in planting plants
	Caring for plants in the school environment
Cleanliness in the school environment	Disposing of garbage in its place
	Sorting organic and non-organic waste
	Not throwing garbage in the school environment

The experimental and control classes were randomly assigned to avoid treatment bias. Participants consisted of students aged 10-11, with a gender balance between boys and girls. The diversity of learner characteristics is an important consideration in analyzing the impact of media on environmental awareness attitudes, as well as ensuring that research results have relevance to heterogeneous basic learning contexts.

The experimental group received treatment using E-KOMINA (E-Komik Mitigasi Bencana Alam) media, while the control group underwent conventional learning without any special media intervention. In this experimental study, conventional learning applied to the control group is precisely defined as a lecture (expository) method and face-to-face teacher-led discussions, where the delivery of natural disaster mitigation material relies entirely on oral explanations and printed sources such as textbooks, and explicitly does not use digital technology-based learning media such as KOMINA e-comics. The implementation of the activity took place over 3 face-to-face meetings. The treatment given to the control group had identical duration and material coverage to the experimental group, so that the learning media variable became the only significant differentiating factor in measuring environmental awareness outcomes.

The research instrument was a questionnaire of 17 questions that were distributed at the end of the lesson. These questions are created with the aim of seeing if students can increase environmental awareness. The questionnaire uses indicators of environmental care attitudes, namely

(1) always keep the class clean which consists of 5 statements,

(2) loving tidiness and cleanliness of the environment consists of 2 statements,

(3) being wise in using natural resources consists of 3 statements,

(4) supporting greening at school consists of 4 statements, and

(5) cleanliness of the school and home environment consists of 3 statements.

Indicators in environmental awareness are developed through questionnaire grids that are systematically compiled to ensure that each indicator is proportionally represented and quantitatively measurable. This instrument aims to evaluate the extent to which learning is able to shape students' awareness and behavior in maintaining the school environment and its surroundings can be seen in **Table 2**.

The questionnaire uses a Likert scale. The Likert scale is described to describe the score. Score 1 (not good), score 2 (quite good), 3 (good) and 4 (very good). For negative item questions, the score is reversed. The data collected was then calculated using quantitative methods and analyzed using Eq. (1):

$$A = \sqrt{\frac{\sum S}{N}} \times 100, \tag{1}$$

where A is the environmental care attitude, S is the total score of the respondent's answer, and N is the maximum score.

Before the instrument is used, a validity and reliability test is carried out first. After calculating the validity test using the Pearson product moment method assisted by SPSS 21.0 software for windows. If the resulting r calculation (0.425-0.703) is greater than the *r* of **Table 2** (0.349), then the instrument question item is considered valid. Meanwhile, the reliability test is carried out after the instrument has been proven to be valid. The reliability test of the instrument with Cronbach's alpha technique yielded a reliability coefficient of 0.736. This value shows a high enough consistency of the question items, so that the instrument can be relied on to measure the variables being studied.

The analysis was then carried out with an independent test sample t-test (SPSS 21 for windows) to test the significance of the mean difference between the experimental and control groups, as the basis for whether the hypothesis was accepted or rejected. The hypothesis is as follows.

H_0. Natural disaster mitigation e-comic (E-KOMINA) has no effect on students' environmental care.

H_1. E-comic for natural disaster mitigation (E-KOMINA) has an effect on students' environmental care.

Table 3. Normality test results

Class	Significance results of post-test	Outcome
Experiment	0.145	Normal
Control	0.320	Normal

Table 4. Homogeneity test results

Variable	Significance results of post-test	Result
Environmental care attitude	0.980	Homogeneous

The basis for t-test decision-making is as follows:

1. If the significance value (2-tailed) ≤ 0.05 and the mean score of the experimental group is higher than that of the control group, then H_0 is rejected. This indicates that the use of E-KOMINA has a significant effect on students' environmental awareness.

2. If the significance value (2-tailed) ≥ 0.05 and the mean score of the experimental group is lower than that of the control group, then H_1 is accepted. This means that the use of E-KOMINA does not have a significant effect on students' environmental awareness compared to conventional learning methods.

RESULTS AND DISCUSSION

The post-test data were subjected to prerequisite tests, including normality and homogeneity tests. The Kolmogorov-Smirnov test was used in this study. The data requirement to meet the assumptions of normality and homogeneity is that the significance value of the test results must be greater than 0.05. The results of the normality test are shown in **Table 3**.

Based on **Table 3**, the normality test analysis shows that the experimental group produced a significance value of 0.145 and the control group had a significance value of 0.320. The test results indicate that the assumption of normality is met by the data of both groups. Next, a homogeneity test was conducted to evaluate the assumption of equality of variance of the research data. In this study, the homogeneity of variance test was conducted using the homogeneity of variance test with the help of SPSS 21.0 for Windows. The results of the homogeneity test can be seen in **Table 4**.

Table 4 shows the results of the homogeneity test with a significance value of 0.980. Since the significance value of the homogeneity test is greater than 0.05, the assumption of homogeneity of variance is met. This means that students' environmental awareness attitudes in both classes have similar variations. A t-test analysis was then conducted, with the results indicating a significant difference in average scores for each environmental awareness indicator between the two groups. This can be seen in **Table 5**.

The posttest results showed that students in the experimental group achieved significantly higher environmental awareness scores compared to those in the control group. This significant difference is clearly reflected in the measured indicators particularly in the 'always keep the class clean' indicator, where there is a notable average gap between the two groups. Students in the experimental group demonstrated a stronger commitment to cleanliness,

Table 5. The average score on each indicator of environmental concern of students in the experimental and control classes

No	Indicator	Experiment	Control
1	Always keep the class clean	90.5	75.0
2	Love tidiness and cleanliness of the environment	85.0	70.0
3	Wise use of natural resources	75.5	72.0
4	Support the greening of the school	75.0	70.0
5	Keeping the house and classroom clean	86.0	75.0
	Average	82.4	72.4

achieving an average score of 90.5, compared to the control group's average of 75. The posttest results also reinforce this finding, with 30 students in the experimental group scoring an average of 84.5, outperforming the 31 students in the control group, who averaged 74.5. This difference shows that using natural disaster mitigation e-comics can more effectively enhance students' understanding and awareness of environmental issues. Visual media like e-comics have been proven to strengthen students' emotional and cognitive engagement in the learning process, especially when the content is connected to real-life experiences and disaster risks (Wibowo & Koeswanti, 2021). In addition, the narrative approach in e-comics enables students to internalize character values more deeply through contextual and reflective storylines (Benardi et al., 2023). These findings support the view that visual and digital learning media can serve as effective tools for character education rooted in environmental values.

The effectiveness of the KOMINA e-comic is highly focused on micro-behavioral changes and direct responsibilities, as evidenced by the large score gaps in the indicators 'always keeping the classroom clean' (15.5 points) and 'loves a neat and clean environment' (15.0 points). Furthermore, students' ability in 'keeping the house and classroom clean' also significantly improved (a gap of 11.0 points), indicating success in generalizing hygiene behaviors to different environments. Success in these behavioral indicators is directly linked to the e-comic's design features: the powerful visual narrative of the flood series, which explicitly links littering to disaster risk, has been shown to strengthen students' emotional and cognitive engagement because the content connects to real-life risks. Studies have shown that character education-based e-comics can internalize values and responsibilities through accessible storylines and characters (Solihah et al., 2022). Furthermore, the character modeling of Gana and Mica, who actively maintain cleanliness, facilitates a deeper internalization of character values through a reflective storyline. In contrast, more collective and abstract indicators such as 'supporting school greening' (5.0 points) and 'wise use of natural resources' (3.5 points) showed more moderate improvements, indicating that although e-comics are effective for specific individual actions, their impact on broader environmental ethical awareness or actions requiring large-scale implementation still requires additional intervention support. To strengthen joint or collective actions, a collaborative and contextual learning approach is needed so that the values learned can be applied in real social situations (Safitri et al., 2024). Integrating e-comics with project-based activities such as school cleanliness programs or

Table 6. Hypothesis test

Class	N	Mean	Significance (2-tailed)
Experiment	30	84.5	0.000
Control	31	74.5	0.000

environmental care actions can expand the learning impact from the cognitive and affective domains to sustainable participatory behavior (Suwanda et al., 2023).

The purpose of the hypothesis test is to determine whether the proposed allegations are acceptable or not. To test the truth of the hypothesis, a statistical test was carried out in the form of a t-test (independent sample test) using SPSS 21.0 for windows.

Based on **Table 6**, the results of the independent sample t-test show a significance level of 0.000 for both the experimental and control groups. Since $0.000 \leq 0.05$ and there is a significant difference in the mean scores between the two groups, the null hypothesis (H_0) is rejected. These findings indicate that the use of natural disaster mitigation e-comics (E-KOMINA) has a significant effect on increasing students' environmental awareness. E-comics present material about natural disasters in a way that is more engaging and meaningful for students by using innovative comic stories that reflect attitudes of environmental care. Research by Anafiah and Rezkita (2020) shows that using comic-based media can boost children's enthusiasm and interest in learning, which in turn significantly improves their competence. Through this approach, students not only gain knowledge and skills but also develop important values that help them–their communities better prepare for growing environmental challenges.

Furthermore, the effectiveness of E-KOMINA as a learning medium lies not only in its visual appeal but also in its ability to deliver ecological messages in a clear, structured, and engaging way. In the context of primary education, students are generally more responsive to media that present information through simple yet meaningful illustrations and dialogues (Huang & Hsin, 2023). E-comics make it possible to integrate disaster mitigation content with sustainability values, helping students understand how their daily actions are connected to the environment and its well-being. These findings align with the character-based education approach, which highlights the importance of contextual and participatory learning (Ismail, 2021). Moreover, the use of digital media such as e-comics supports the development of students' visual and technological literacy–key competencies needed in 21st century learning (Millaku et al., 2023). Therefore, E-KOMINA serves not only as a learning tool but also as a medium for character building that responds to today's ecological and disaster challenges. This research provides an important contribution to the development of innovative learning media that simultaneously supports character education and sustainability. The implementation of E-KOMINA in the classroom can be seen. The implementation E-KOMINA in the classroom can be seen in **Figure 2**.

In building environmental awareness at the elementary level, contextual and interactive learning media are highly effective in nurturing students' sense of care for the environment and equipping them with disaster mitigation skills from an early age. Learning media that connects with

Figure 2. E-comic implementation activities based on natural disaster mitigation at UM Laboratory Elementary School, Indonesia (Source: Field study)

students' daily lives can enhance their engagement in the learning process. One such medium is interactive e-comics that focus on the theme of natural disaster mitigation. At UM Laboratory Elementary School, environmental awareness is fostered through the use of e-comics as an integral part of the learning strategy. These e-comics are designed to deliver important information through engaging visuals and storytelling, making it easier for students to understand. Their use aims to equip students with the knowledge and skills they need to face natural disasters (Anafiah & Rezkita, 2020; Bachri et al., 2024).

Furthermore, the basic education curriculum should be designed comprehensively to cover various disaster aspects that are relevant to both local and national contexts. Understanding different types of disasters such as earthquakes, floods, and wildfires needs to be an integral part of the curriculum (Benardi et al., 2023; Mutia et al., 2025). In addition, students should be introduced to the concepts of risk and vulnerability, which can amplify the impacts of disasters (Rahma, 2018). The curriculum should also equip students with appropriate and measurable actions to reduce the negative impacts of potential disasters (Parastika et al., 2022; Sulistiyani, 2022). Integrating disaster mitigation materials into the curriculum can be carried out through thematic and project-based approaches. In this context, interactive e-comics with a natural disaster mitigation theme can serve as an effective tool to embed disaster education into school learning (Parastika et al., 2022).

Interactive e-comics are a form of digital media that appeal to students because they combine visual and narrative elements in a dynamic way (Bachri et al., 2024). In the context of natural disaster mitigation, e-comics offer the advantage of presenting information about different types of disasters and mitigation measures in a more communicative and easy-to-understand format. These media combine images, text, videos, and interactive elements such as simulations, which can greatly enhance students' understanding of abstract concepts related to disasters and their management (Benardi et al., 2023). Through this approach, students don't just receive information they engage in a learning experience that is both

reflective and practical. The use of interactive e-comics with a natural disaster mitigation theme also helps shape students' character, fostering environmental awareness, critical thinking, empathy, and social solidarity (Hakim, 2023; Wibowo & Koeswanti, 2021). In this way, interactive e-comics are not just an educational tool but also a powerful medium for instilling humanitarian values and promoting sustainability in disaster education.

Interactive e-comics not only serve as a medium to deliver information but also play a role in shaping students' character through various aspects of disaster education. In terms of environmental awareness, e-comics can illustrate the impact of natural disasters on both the environment and human life (Nasrullah et al., 2018). These visualizations help students better understand the importance of protecting nature and foster a sense of care for their surroundings. In terms of critical thinking skills, students are encouraged to analyze situations and explore disaster mitigation solutions through interactive and reflective storylines (Ratnasari & Ginanjar, 2020; Syaflita et al., 2021). This process strengthens their ability to think logically and solve problems that are relevant to real-life situations (Utami et al., 2021). In addition, e-comic narratives also help nurture empathy and solidarity by allowing students to connect emotionally with disaster victims and understand the importance of social support. Therefore, the use of e-comics with a natural disaster mitigation theme can help nurture students' environmental awareness while shaping their social character. It also inspires them to take part in humanitarian efforts to support disaster victims and fosters a sense of solidarity within community (Noviana et al., 2021).

CONCLUSIONS

Based on the analysis of the research data, it can be concluded that the use of e-comics with a natural disaster mitigation theme has a significant impact on increasing students' environmental awareness. This is supported by the hypothesis test results, with a t-test value of $0.000 \leq 0.05$, indicating a statistically significant difference before and after the treatment. E-comic media not only serves as an engaging visual learning tool, but also effectively delivers ecological messages in a contextual and relatable way. By weaving natural phenomena and disaster issues into everyday life through visual stories, students can more easily grasp the urgency of environmental conservation and the importance of taking preventive action against disaster risks. E-comics, as an innovative learning medium, have proven effective in fostering ecological awareness, strengthening character values, and encouraging students to actively take part in protecting the environment. This medium also supports a technology-driven learning approach that aligns well with the nature of today's digital generation. Therefore, developing e-comics with a disaster mitigation theme can serve as a sustainable educational strategy to shape a generation of learners who are disaster-aware, environmentally conscious, and equipped with strong visual literacy. These findings highlight the importance of embedding sustainability values into learning design.

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