

Development of Digital Comics as a Source of Disaster Mitigation Education: A Case Study on Building Resilience among Youth

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Abstract

The development of photo-based digital comics is one of the fastest-growing digital media and is in great demand. This learning medium is an innovative blend of visual arts and education that offers tremendous potential in stimulating interest in and understanding of complex materials. The importance of understanding disaster mitigation in modern environmental and social challenges cannot be ignored. Drama, as a rich form of cultural expression, allows us to reflect on human life, social relations, and the challenges faced by society. Disaster mitigation is becoming increasingly important to deal with real threats due to climate change and society's vulnerability to natural disasters. This learning concept is especially effective for students who need an innovative and interesting approach. The development of photo-based digital comics as teaching materials is very interesting. Combining visual elements from photographs with strong narratives, digital comics will be able to present complex materials in an easy-to-digest form. This approach provides a great opportunity to convey information on learning and the importance of disaster mitigation in a way that is closer to students' daily lives, resulting in more authentic and embedded learning. This research focuses on efforts to develop teaching materials that are communicative, not boring, effective, and applicable to support creativity and increase students' understanding of social problems identified in society.

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Introduction

The fusion of art and disaster mitigation through the development of photo-based digital comics not only allows students to appreciate the beauty of comics as an art form but also makes them aware of the importance of preparedness and preventive actions in the face of real disasters. As a result, future generations will have a deeper and more holistic understanding and concern for social and environmental realities (Mataram et al., 2021; Şentürk, 2023; Zakaria et al., 2023).

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The idea of developing photo-based digital comics as instructional materials is intriguing because the combination of strong visual elements from photos with a compelling narrative makes digital comics capable of presenting complex material in an easily understandable format. This semi-authentic learning approach provides an opportunity for conveying the importance of disaster mitigation information in a way that is closer to students. Using comics in education can be an effective way to engage students and enhance their critical thinking skills (Arief et al., 2022; Wallner, 2020). Specifically, in the development of photo-based digital comics, it has become an innovative blend of visual art and education, offering great potential in stimulating interest and understanding of complex material (Dwiputra et al., 2020; Keskin & İlhan, 2021).

As an instructional material, disaster mitigation can help students understand the material and apply it to themselves and their environment. Communicative and interactive teaching materials can assist students in comprehending the knowledge being taught. Effective and applicable teaching materials are expected to support creativity and promote self-directed learning for students (Syarah et al., 2018; Alfi et al., 2019; Bugdayci & Cetinkaya, 2022; Fitria, 2023).

Understanding disaster mitigation is crucial in the face of modern environmental and social challenges. Drama, as one of the forms of cultural expression, allows humans to reflect on their lives, social relationships, and the challenges faced by society. On the other hand, disaster mitigation is becoming increasingly important due to climate change and society's vulnerability to natural disasters. By teaching students about disaster mitigation, they can develop a sense of responsibility towards their community and become proactive in reducing disaster risks (Nakano & Yamori, 2021). However, effectively teaching these concepts to students requires an innovative and engaging approach (Suharini et al., 2020).

The development of photo-based digital comics that combine disaster mitigation and local wisdom also enriches drama education in schools. Through digital comics, students not only develop dramatic skills but also understand the significant role of culture in facing real challenges. This provides a profound and sustainable learning experience " (Callender et al., 2020). This approach has been adopted by several progressive schools worldwide that have successfully implemented teaching through digital comics. For example, the Innovation International School in Singapore has reported a significant increase in student engagement and their understanding of dramatization and disaster mitigation through the use of digital comics as teaching materials (Arief et al., 2022). Given its tremendous potential, this article discusses the design of photo-based digital comics that combine local cultural elements with practical steps in disaster mitigation as a drama teaching material in schools. This article can provide a fresh perspective in the field of education, especially in drama learning, and offer concrete solutions for the increasingly complex challenges of 21st-century education.

Literature Review

The research by Sentürk & Simsek (2021) stated that educational comics are effective for social studies education in Turkey. Similar studies also show the effectiveness of digital comics in increasing students' interest and discipline (Presser et al., 2019; Wicaksono & Jatu Wayu, 2021). Latif et al., (2020) showed that learning with comic media is effective in enhancing student activities and outcomes in mathematics. Amrizal (2022) revealed that comic strips are effective in descriptive writing lessons.

The development of e-comics as teaching materials was also carried out by Dwiasih & Agung (2021), and the developed product is suitable for Indonesian language education for second-grade elementary school students (Dwiasih & Agung, 2021). This is in line with Kusrini et al. (2020) research, which developed comics to improve Japanese language writing skills, which was also effective for speaking and reading (Kusrini et al., 2020). Nasution et al., (2019) developed meme comics as teaching materials for writing anecdotal texts, and the result was deemed suitable in terms of content, presentation, language, and design (Nasution et al., 2019). Wati (2022) conducted a development study that showed that children's environmental-themed comics, which are clean, healthy, and beautiful, are highly suitable for lower-grade students' reading materials (Wati, 2022). The research by Sulistio & Qohar (2020) showed that mathematics teaching media in comic-based Android-based story games can increase students' positive enthusiasm for learning (Sulistio & Qohar, 2020).

Method

This research is based on the research and development approach by Borg & Gall, aimed at systematically developing and validating a new educational product, and assessing the effectiveness of the product used in learning (Dewahrani et al., 2023; Sugiyono, 2019).

— Development Procedure

The product development begins with designing a systematic research and development process based on Borg & Gall's model. The steps in this research are information gathering, consisting of potential and problems, literature review, product design, content design, and validation and revision of design and content. The information gathered regarding potential and problems indicated that the instructional materials being used were not engaging, and students had limited knowledge of disaster mitigation. The literature review revealed that similar research had not been conducted in the Indonesian language subject. Information gathering and product design were carried out to

define the scope of the research, involving the collection of photos from Indonesian Volunteer Society (MRI) volunteers. Meanwhile, for content and the collection of disaster mitigation photos, it was necessary for designing digital comics as a drama learning medium. Disaster mitigation was limited to the themes of earthquakes, floods, landslides, fires, and Covid-19. The Comica application was chosen after evaluating several comic development applications on the Playstore. The selection was based on the need for storage space, a variety of design filters, and the ability to be used without an internet connection.

During the product design phase, design, validation of design and content, and revision of design and content were carried out. The product and content design included defining the skills that needed to be learned, such as drama skills, photo editing using the Comica app, and disaster mitigation. It also involved formulating research objectives and determining the sequence of learning. Validation was performed by three experts in instructional materials, disaster management, and drama education. Revisions were made based on the feedback from the validation results.

The development subjects in this research included experts in disaster management, instructional material development, and drama education users. The data collected were in the form of quantitative descriptive data obtained from the validation results of three validators. The data collection technique used a questionnaire. The data collection instrument consisted of a list of questions related to the developed instructional materials. In addition to validation subjects, activities involved students and teachers. Data analysis techniques included qualitative descriptive analysis for student questionnaires and interviews with teachers, as well as simple statistics using a formula to determine the percentage of product validation ratings (Sugiyono, 2019).

$$P = \frac{f \times 100}{n}$$

After analyzing each assessment instrument, the overall average value of the validation of instructional materials was calculated using the formula for the percentage of validity.

Results

The development/design of photo-based digital comics with elements of local wisdom in disaster mitigation as drama learning materials was carried out in accordance with the R&D steps. Research data included initial information and product development results. The research began by analyzing potential and problems by assessing the needs of students and teachers using a questionnaire instrument. The questionnaire results and interviews are presented in Table 1 below.

Table 1: Summary of Questionnaire Results for Needs Analysis.

Question Items		Answer	Percentage
Questionnaire for teachers	In the learning process, do you use teaching materials in e-learning?	Yes	60%
		No	20%
		Sometimes	20%
	Are the teaching materials used or uploaded in e-learning aligned with the content being delivered?	Yes	100%
		No	-
		Sometimes	-
	What teaching materials do you frequently use in e-learning?	Video/Film	48%
		Module	52%
	Is the use of teaching materials in e-learning sufficient for Indonesian language learning?	Already	32%
		Less	60%
		No	8%
	What reasons underlie your answers to the above questions?	Don't have	76%
		More quota	12%
		Still confused	12%
	In online learning, do Indonesian language materials, whether oral or written, pose difficulties for students?	Boring	16%
Questionnaire for students		Yes	8%
		No	76%
		Sometimes	100%
	Is it necessary to use teaching materials for Indonesian language learning?	Yes	-
		No	-
		Sometimes	100%
	Should drama learning materials also be used for drama instruction?	Yes	-
		No	-
		Other	68%
	What type of teaching materials do you prefer during the pandemic?	Photo/Image	8%
		Textbook	12%
		Module	12%
		Worksheet	100%
	Are you familiar with comics, especially digital comics?	Yes	-
		No	-
		Other	84%
	Have you ever created digital comics?	Yes	16%
		No	-
		Other	20%
	Have you used digital comics as teaching materials?	Ever	80%
		Never	-
		Other	68%
	Are you interested in using digital comics as drama teaching materials?	Yes	12%
		No	20%
		Uncertain	32%
	Do you understand disaster mitigation?	Yes	60%
		No	8%
		Other	36%
	Have you ever received teaching materials based on disaster mitigation?	Yes	64%
		No	-

The survey results indicate that more than half of the students (50%) state that teachers do not always use teaching materials, and a quarter of the students (25%) mention that the dominant teaching materials used are modules. Students feel that the teaching materials used by teachers are not sufficient to ensure success in the learning process because they lack engagement (mostly consisting of text) for most students. All students want every lesson to include teaching materials, including drama learning. Students prefer teaching materials in the form of photos/images, and most are familiar with digital comics. Ironically, most students have never used them and are interested in doing so. Regarding disaster mitigation, over half (50%) of the students say they don't understand it and have never received disaster mitigation materials.

The interview results show that teachers are already using engaging methods, but they face certain limitations in implementation. The learning process primarily relies on textbooks, which students are not accustomed to reading. Meanwhile, students prefer learning that involves games and digital content. Therefore, students' literacy levels need to be supported with appropriate teaching materials so that Indonesian language material can be effectively conveyed, thereby achieving the learning objectives and optimal student outcomes. Using enjoyable, student-centered teaching materials can pave the way for optimal learning outcomes.

Based on the survey and interviews with students and teachers, it can be concluded that the need for teaching materials in education is urgent. According to students, learning is enjoyable and the material is absorbed effectively when teachers use engaging teaching materials. One such material is disaster mitigation-based digital comics. Digital comics, in particular, are highly favored by students and engaging, which is why there is a need to develop teaching materials in the form of digital comics based on disaster mitigation to aid the learning process.

— Initial Data Collection and Product Design

In summary, the development process is depicted in the following figure:



Figure 1: Design of the Process and Outcomes.

The development of teaching materials was carried out by collecting photos obtained from a volunteer team, editing them with the chosen application, and arranging the photos into a visual storytelling format. The collection of volunteer photos related to disaster mitigation from the Indonesian Volunteer Society (MRI) was used as the basis for comic-style drama learning. The disaster mitigation theme was limited to earthquakes, floods and landslides, fires, and Covid-19. Interviews with the volunteer team indicated the paramount importance of disaster mitigation. While this is crucial for students, schools do not provide education on disaster mitigation. Disaster mitigation needs to be introduced at an early age so that children can learn how to protect themselves during disasters. This teaching material development used original photos from the volunteer team, which were processed into comics.

— Product Development

The design and content of the digital comic teaching materials included creating cover pages and the story content, which comprised learning about Covid-19 mitigation, fire mitigation, earthquake mitigation, flood, and landslide mitigation. Below is an example of the developed comic on the theme of earthquake mitigation:



Figure 2: Example of Comic Development.

— Validation of Design and Content

The validation of the local wisdom-based digital comic teaching materials by instructional experts encompassed various assessment aspects, such as the comic's appearance, image presentation, materials, content, and structure, as seen in Table 2 below. The validation of the local wisdom-based digital comic teaching materials by instructional experts included assessing the following aspects:

Table 2: Assessment of Disaster Mitigation-Based Digital Comics by Instructional Experts.

Aspects	Indicator	ΣX	Score %
Comic	Creativity in ideas and concepts.	33	94,28%
	Clarity of the text.		
	Clarity of sentences.		
	Clarity of images.		
	Writing the name and title of the teaching material.		
	Suitability of the application used.		
Display	Image selection.	13	86,66%
	Use of color.		
	Suitability of images with the text.		
Material	Creativity in the selection of materials.	10	100%
	Quality of materials used.		
Contents	Alignment of content with the National Curriculum (KI and KD).	25	100%
	Alignment of content with the needs of teaching materials.		
	Alignment of content with indicators in drama teaching.		
	Ease of use of the teaching material.		
Structure	Alignment of assessment with the content.	15	100%
	Presence of usage instructions for the teaching material.		
	Systematic structure of drama material.		
	Sequence of presentation of disaster mitigation-based comics following the drama structure.		
These aspects were considered for the validation of the teaching materials to ensure their effectiveness and appropriateness for the learning process.		96	96%
Average		96	96%

Validation by instructional experts encompassed assessing aspects of comic appearance, image presentation, story content, and structure, all of which fell within the categories of suitable to highly suitable. Overall, the assessment by instructional experts reached 96% with a highly suitable category. However, there were some revision suggestions, such as for the cover, introduction, user guide, and improvements to writing errors or typos in some parts of the comic. Several comments and suggestions that arose during the teaching material validation indicated that this material was considered a brilliant idea because it introduced new variations in Indonesian language learning. The material was perceived as making learning more engaging and overcoming the students' perception that Indonesian language lessons are typically monotonous and dull. In addition to the validation by instructional experts, the validation results by disaster management experts, which included an assessment of the content and structure of disaster mitigation, are presented in Table 3.

The assessment of disaster mitigation-based digital comics by disaster management experts included evaluating several aspects, as listed below:

Table 3: Assessment of Disaster Mitigation-Based Digital Comics by Disaster Management Experts.

Aspect	Indicator	ΣX	Score %
Contents	Alignment of disaster mitigation content with the material.	13	86,66%
	Selection of disaster mitigation materials that are easy to apply.		
Structure	Selection of disaster mitigation materials that are commonly encountered in the local environment.	16	80%
	The systematic presentation of exemplified disaster mitigation.		
	The sequence of presenting disaster mitigation.		
	The completeness of presenting disaster mitigation.		
Average	Suitability of teaching aids in disaster mitigation.	29	82,85%

These aspects were considered during the validation process to ensure that the disaster mitigation content and its presentation were relevant, practical, and effective in educating students about disaster preparedness and mitigation in their local context.

The assessment of disaster management experts on the content and structure of disaster mitigation reached 86% and 80%, respectively, indicating that both aspects were highly suitable. As a result, this developmental product is ready for the learning process. According to disaster management experts, disaster mitigation-based digital comics can be used in education. This method helps students understand, prepare for, respond to, and become resilient in the face of disasters. Some improvements are needed, including correcting writing errors or typos in certain parts of the comic.

The third validation phase involves teaching material users or experts in the field of drama education. This validation aims to identify weaknesses, strengths, and errors related to disaster mitigation-based digital comic teaching materials, particularly in the context of drama education. The assessment by teaching material users includes the teaching material's structure, content, and its educational benefits. Based on the validation results from disaster management experts, the development of disaster mitigation-based digital comics is considered highly suitable as an educational tool for disaster mitigation, particularly as a teaching material in schools. Suggestions for improvement may be considered for the product revision phase. The third validation phase involves teaching material users or drama education experts, aiming to identify weaknesses, strengths, and errors related to disaster mitigation-based digital comic teaching materials, particularly in the context of drama education. The assessment by teaching material users includes an evaluation of the teaching material's structure, content, and its educational benefits. The results of the assessment by teaching material users for disaster mitigation-based digital comic teaching materials in drama education are presented in Table 4. The assessment by teaching material users included evaluating the following aspects in disaster mitigation-based digital comic teaching materials:

Table 4: Assessment of Disaster Mitigation-Based Digital Comics by Teaching Material Users.

Aspect	Indicator	ΣX	Score %
Structure	The level of appeal of teaching materials to students.	31	88,57%
	The displayed layout of teaching materials.		
	The selection of the teaching material's name or title.		
	Image selection in the teaching material.		
	The use of color.		
	Creativity in selecting teaching materials.		
Contents	Suitability of the application used.	16	80%
	Alignment of content with the National Curriculum (KI and KD).		
	Alignment of content with teaching needs.		
	The completeness of the material presented in teaching materials.		
Benefits	Suitability of the assessment format for drama material.	17	85%
	The benefits of teaching materials for student in Indonesian language learning.		
	The benefits of teaching materials for teachers in drama material.		
	The benefits of teaching materials for enhancing students' drama skills.		
Average	The benefits of teaching materials in sparking students' enthusiasm and creativity in learning.	64	85,33%

The validation results by teaching material users indicate that the teaching material structure in disaster mitigation-based digital comics is considered highly suitable. Similarly, the content of the teaching material is considered suitable, and the educational benefits of the teaching material are highly suitable. The overall validation results show that the materials are highly suitable for testing in the school learning environment. These aspects were assessed to ensure that the disaster mitigation-based digital comic teaching materials were engaging and met the educational needs of students and teachers in the context of drama education.

According to teaching material users, disaster mitigation-based digital comics meet the requirements for use as teaching materials in drama education, particularly in the context of remote or online learning. Some areas that need improvement include Lesson Plans and addressing writing errors or typos in certain parts of the comic.

Based on the validation results by teaching material users, the development of disaster mitigation-based digital comics is considered highly suitable as a teaching resource that can be used in both online and in-person learning in schools, especially in the context of drama education. Further improvement and revision of the product should be considered for continuous development. The validity data regarding the validation by teaching material experts, disaster management experts, and teaching material users/drama education experts in disaster mitigation-based digital comics as teaching materials for drama education are presented in Table 5. Here is a summary of the validity percentages for the teaching materials related to Disaster Management and Drama Education:

Table 5: *Percentage of Teaching Material Validity.*

Tim Validator	Percentage
Teaching Materials: The teaching materials for disaster mitigation-based digital comics were found to be highly suitable with a high percentage of validity.	96%
Disaster Management: The teaching materials related to disaster management in the digital comics were considered highly suitable with a high percentage of validity.	82,85%
Drama Education: The teaching materials in the context of drama education within the digital comics were also considered highly suitable with a high percentage of validity.	85,33%

These results indicate that the developed digital comic teaching materials effectively align with the subjects of disaster management and drama education, making them highly appropriate for use in both areas of study. The validation results for the development of disaster mitigation-based digital comic teaching materials fall into the "highly valid" category. This data indicates that the digital comic, which is based on disaster mitigation, can be used for testing in both in-person and online learning environments. Furthermore, based on the recommendations from the validation team, this disaster mitigation-based digital comic can also be applied in other subject areas.

— Revisions to Design and Content

The product revisions are guided by the suggestions provided during the validation process by the validation team. These suggestions help improve and enhance the teaching materials, making them more effective and suitable for various educational contexts, including typo/writing errors in some parts of the disaster mitigation content.

Discussion

The use of the Comica application in this study proved to be an effective tool for producing comic-style images and was reliable for product development. Comica can support the critical issue of comic development in the context of education, which continues to receive attention from researchers and education practitioners. Digital comics provide an engaging, creative, and effective method for teaching various concepts, including disaster mitigation. This method integrates strong visual elements and narration to facilitate student understanding, particularly in the context of drama-based learning. As Uribe-Jongbloed & Aguilar-rodríguez (2020), an education expert at Global Creativity University, noted, the integration of photo-based digital comics in dramatic education offers a holistic approach to developing students' creative skills and problem-solving abilities. This also opens up opportunities to introduce disaster mitigation concepts at an early age, creating awareness among the younger generation about the importance of preparedness in emergency situations (Uribe-Jongbloed & Aguilar-rodríguez, 2020).

This study further reinforces previous findings in the development of comics that can be used as educational tools for disaster mitigation, especially as teaching materials in schools. In addition, the improvement suggestions made by experts and users of the teaching materials in this study allow for further development to enhance the effectiveness of learning. For example, in a study by Smith (2023), an emphasis on local knowledge in photo-based digital comics on disaster mitigation in earthquake-prone areas helped students feel more connected to the learning material. When students see characters in the comic

taking actions based on local wisdom, such as bird behavior warnings before an earthquake, they feel like a part of the solution, valuing ancestral knowledge in a modern context. Research by Ramadhan et al. (2019) emphasized the need to increase knowledge about the environment and disaster mitigation through language education (Ramadhan et al., 2019).

Rutta et al. (2020) developed comic books for burn prevention and first aid literacy (Alvarado, 2020). Syarah et al. (2018) developed electronic comic media to improve early childhood marine conservation understanding, and the result was effective in significantly increasing children's marine conservation understanding (Syarah et al., 2018). Ningsih et al., (2022) developed digital comics research that can be used as an alternative learning material for reading folklore/fables (Ningsih et al., 2022).

Based on the results of these studies, the use of comics in an educational context focuses not only on students' creativity and problem-solving aspects but also opens the door to introducing disaster mitigation concepts at an early age. Awareness of the importance of preparedness in emergency situations becomes a key aspect of using photo-based digital comics for disaster mitigation.

Conclusion

The development of photo-based digital comics on local wisdom disaster mitigation for drama-based learning in schools is an urgent need that is desired by both teachers and students in the learning process. Digital comics offer an alternative to prevent student boredom in drama-based learning, which often relies on text-based modules. These digital comics allow teachers and students to be creative, promoting critical and creative thinking, which is highly relevant to the soft skills needed in the 21st century. Disaster mitigation, the focus of these digital comics, should be taught from an early age, especially with an emphasis on local wisdom, given the increasing frequency of natural disasters. This comic development has taken into account field needs and involved photo owners and the Comica application, which played a crucial role in creating drama-based learning materials. After validation by three experts—curriculum experts, disaster mitigation experts, and drama-based learning experts—these local wisdom disaster mitigation-based photo comics are ready for trials after the revision process. A similar learning model can be developed with a focus on different aspects of local wisdom and applied in various subjects, including science, social studies, and religion.

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