

Development of E-Books as Educational Media to Introduce Disasters to Early Childhood

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ABSTRACT

Indonesia's geographical position along the Pacific Ring of Fire makes it highly vulnerable to natural disasters such as earthquakes, floods, and tsunamis. Early childhood education plays a critical role in preparing young learners to recognize hazards and respond appropriately during emergencies. However, disaster education for children is often limited to conventional methods that lack interactivity and developmental alignment. This study aimed to develop and evaluate an interactive e-book designed to enhance disaster preparedness among children aged 4–6 through a developmentally appropriate, engaging, and multimedia-based approach. Using an Educational Design Research (EDR) framework, the study involved iterative phases of needs analysis, product design, expert validation, revision, and limited field testing. Data were collected through interviews, observation sheets, teacher questionnaires, and expert validation rubrics. The e-book incorporated child-friendly illustrations, animations, narration, and interactive games. Expert validators rated the e-book as "Very Eligible" (97.9%) based on content accuracy, visual appeal, language clarity, and interactivity. A field test with 12 children at PAUD Al Hidayah showed a significant improvement in disaster knowledge, with posttest scores increasing from an average of 35.83 to 72.5. Children demonstrated high engagement and adaptability when interacting with the e-book, reinforcing the effectiveness of multimedia tools in early disaster education. The findings support integrating digital media into early childhood curricula to foster resilience and disaster literacy. Future research should explore the long-term behavioral impacts of disaster e-books and their integration with emerging digital platforms such as mobile apps and augmented reality to broaden access and educational impact.

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1. INTRODUCTION

Indonesia is one of the countries most prone to natural disasters due to its location along the Pacific Ring of Fire. This geographical setting contributes to the frequent occurrence of earthquakes, volcanic

eruptions, floods, and tsunamis (Lulang et al., 2024). The impacts of such disasters extend to all age groups, including children, who are particularly vulnerable in emergency situations due to their physical and emotional immaturity (Atmojo, 2020). Consequently, it is essential to provide disaster education from an early age to help children recognize potential threats, understand the risks, and respond appropriately when disasters occur (Dewi et al., 2023). Delivering this education in a developmentally appropriate way can reduce panic and increase preparedness among young children (Nasrullah & Reza, 2020).

Theoretical foundations for early childhood disaster education draw from Piaget's theory of cognitive development and Vygotsky's social learning theory. According to Piaget (2018), children in the preoperational stage (ages 2–7) process information through symbolic thought, visual imagery, and concrete experiences. Therefore, disaster education should utilize visual tools such as illustrations, animations, and interactive content to facilitate understanding. Vygotsky's (2019) theory underscores the role of social interaction in learning, emphasizing the importance of collaborative activities involving peers and adults, such as discussions, role plays, and guided simulations.

Research indicates that early disaster education positively influences children's awareness and preparedness. Setiawan et al. (2020) found that children who receive disaster education demonstrate higher levels of readiness than those who do not. This reinforces the need to integrate disaster education into the early childhood curriculum, aligning instructional methods with children's developmental needs (Lilianti et al., 2023; Anindhita et al., 2024).

With the advancement of digital technology, interactive digital media such as e-books have emerged as powerful tools for early childhood education. Compared to traditional learning materials, interactive e-books can significantly enhance engagement and motivation (Hadaya & Hanif, 2019). Specifically, in the context of disaster education, e-books that include colorful illustrations, animations, and educational games offer a more concrete and enjoyable learning experience for children (Purnamasari & Wijayanti, 2021). These media help children better recognize different types of disasters, identify warning signs, and understand the appropriate emergency responses (Dewi et al., 2024).

The development of disaster education e-books for early childhood requires a holistic approach that considers visual appeal, interactivity, and educational value (Panggabean et al., 2024). A well-designed e-book should not only be aesthetically engaging but also developmentally appropriate, conveying information in a way that aligns with children's cognitive abilities (Ningsih et al., 2022). Interactive features such as simple simulations and scenario-based games can offer children hands-on experiences that strengthen both their knowledge and preparedness skills (Rahmawati et al., 2019; Ghasya & Kartono, 2021).

By integrating educational theory and digital innovation, interactive e-books present a promising approach to early childhood disaster education (Ratnasari & Ginanjar, 2019). Aligning with Piaget's emphasis on symbolic representation and Vygotsky's stress on social context, these e-books can deliver meaningful learning through visual, interactive, and collaborative formats. Through activities such as quizzes, simulations, and story-based games, children are not only introduced to disaster-related concepts but also equipped with the knowledge and confidence to act during emergencies.

In conclusion, early childhood disaster education delivered through interactive e-books holds strong potential to cultivate a generation that is more aware, prepared, and responsive to disasters. Children exposed to such education demonstrate a greater understanding of hazards and improved readiness to manage emergencies (Setiawan et al., 2020). With the thoughtful integration of technology and pedagogical theory, interactive e-books can serve as effective tools in building disaster resilience from an early age.

Based on the preceding discussion, this study seeks to explore several key research questions. First, how can interactive e-books be designed to align with the cognitive and social development stages of early childhood learners in the context of disaster education? Second, to what extent do interactive features—such as animations, simulations, and games—enhance children's understanding, engagement, and preparedness for disasters? Third, how effective are interactive e-books compared to conventional learning methods in improving disaster knowledge and emergency response skills among young children?

By addressing these questions, the study aims to contribute empirical evidence to the growing field of early childhood disaster education and provide practical guidance for the development of pedagogically sound and technologically enriched educational materials.

2. METHODS

This study employed an Educational Design Research (EDR) approach, which is appropriate for developing and evaluating educational products within authentic learning environments. The EDR method enables researchers to systematically design, implement, and refine interventions—such as teaching materials, strategies, or systems—based on empirical data and theoretical grounding (Plomp, 2013; Akker et al., 2006). This approach was selected because it supports the development of practical solutions to real-world educational challenges while contributing to theoretical understanding.

2.1 Research Design

The study followed a formative EDR model, involving iterative stages of analysis, design, development, and evaluation. The primary aim was to create an illustrated storybook (interactive e-book) to introduce early childhood learners to disaster preparedness in a developmentally appropriate and engaging way. The research was structured in the following stages: (1) needs analysis, (2) product design, (3) product development, (4) expert validation, (5) product revision, and (6) limited field testing.

2.2 Population and Sampling Technique

The target population for this study was children aged 4–6 years enrolled in early childhood education institutions in Indonesia. A purposive sampling technique was used to select one early childhood education center for the initial field test, considering its readiness to participate in technology-based interventions and disaster education activities. Participants also included subject matter experts in early childhood education and disaster risk reduction.

2.3 Data Collection Instruments

Data were collected using a combination of instruments, including:

- Observation sheets to document children's engagement and behavior during e-book use.
- Questionnaires for teachers to assess usability, clarity, and content relevance.
- Interview guides for collecting qualitative feedback from educators and experts.
- Validation rubrics for expert review of the content and design of the e-book.

2.4 Expert Validation

The e-book underwent expert validation by three professionals: an early childhood education specialist, a disaster preparedness trainer, and an instructional design expert. Each expert assessed the product using a structured rubric that evaluated criteria such as content accuracy, developmental appropriateness, visual appeal, interactivity, and usability. The rubric used a 4-point Likert scale ranging from 1 (not appropriate) to 4 (highly appropriate). Scores and qualitative feedback were used to inform revisions of the e-book.

2.5 Product Revision and Testing

Based on expert input, the e-book was revised to improve clarity, engagement, and alignment with cognitive and emotional development levels of young children. A limited field test was then conducted with a small group of learners and teachers to assess the practicality and effectiveness of the product. Observations and teacher feedback were analyzed to determine whether further refinements were needed before broader implementation.

3. FINDINGS AND DISCUSSION

3.1 Needs Analysis

Interviews with educators at PAUD Al Hidayah, Taman Sari Subang, revealed that disaster preparedness education had already been introduced in early learning activities. However, these efforts relied primarily on conventional methods such as storytelling, singing, and basic discussions. Educators acknowledged that while these approaches are familiar and simple to implement, they lacked interactivity and were often insufficient for enhancing young children's comprehension of emergency response strategies. A key challenge identified was the absence of engaging and developmentally appropriate media that could hold children's attention and facilitate deeper learning.

Children in the preoperational stage benefit from visual and experiential learning, yet current teaching resources at the institution remained largely traditional, with limited use of multimedia or digital tools. Educators expressed concern that these limitations hindered children's ability to fully grasp abstract disaster concepts, such as the sequence of actions to take during an emergency. Some children, for instance, could identify natural disasters like floods or earthquakes, but were unsure of appropriate safety responses such as drop-cover-hold techniques or evacuation procedures. This indicated a gap between recognition and actionable understanding.

In addition, several educators emphasized that repeated exposure and interactive practice are critical for reinforcing learning in early childhood, something current methods failed to provide. Furthermore, parental involvement in disaster preparedness learning was minimal, despite its potential to reinforce understanding at home. Parents often lacked access to structured materials that could be used outside the classroom, limiting their ability to support or extend their children's learning. This feedback affirmed the need for an accessible, visually engaging, and interactive digital resource—such as an e-book—that could support both children and their caregivers in building foundational knowledge and confidence in disaster preparedness.

3.2 Product Design and Development

The design of the interactive e-book was guided by both pedagogical principles and technological innovations, ensuring alignment with the cognitive, emotional, and developmental characteristics of early childhood learners. Recognizing that children in the preoperational stage learn best through visual, auditory, and hands-on experiences, the e-book was deliberately structured to provide a multisensory learning environment that fosters engagement and comprehension. A multidisciplinary team—comprising early childhood educators, graphic designers, disaster education specialists, and digital media developers—collaboratively developed the content and user interface to ensure it was educationally sound, visually appealing, and developmentally appropriate.

The development process involved several key components:

- Constructing a Media Program Outline (GBPM), which served as a blueprint for aligning learning objectives with content flow and identifying interactive features to be embedded throughout the e-book.
- Designing visual and audio components, including full-color, age-appropriate illustrations, simple animations to depict disaster scenarios, voice narration, and thematic sound effects to enhance immersion and emotional connection.
- Incorporating interactive elements such as drag-and-drop quizzes, disaster response simulations, and scenario-based games designed to reinforce learning through decision-making and repetition.

The digital development phase utilized Canva for layout and design due to its flexibility and ease of use, particularly in crafting child-friendly visual elements. The completed e-book was then converted into an interactive flipbook using Heyzine, allowing for intuitive navigation and interactive media integration. The final product featured A4 formatting for accessibility and print compatibility, vibrant color schemes to attract attention, readable, dyslexia-friendly fonts, and engaging child-oriented

illustrations. Voice narration was included to support emergent readers, ensuring that children at varying literacy levels could access and comprehend the material effectively. These thoughtful design choices aimed to create a joyful yet educational experience, fostering early disaster literacy in a way that is both meaningful and memorable.

3.3 Validation Process

Three expert validators—each representing a key domain in the development of early childhood educational media—evaluated the interactive e-book using a structured rubric. These experts specialized in early childhood education, disaster preparedness, and educational media design, ensuring a comprehensive review of both pedagogical quality and technical execution. The validation process aimed to assess the feasibility, usability, and educational appropriateness of the e-book before it was tested with children.

The structured rubric applied in the validation process included evaluation criteria such as:

- Content relevance (alignment with learning objectives and disaster education standards),
- Visual appeal (age-appropriate illustrations, color schemes, and layout),
- Language clarity (use of child-friendly and developmentally appropriate language),
- Level of interactivity (presence of meaningful and engaging user interactions).

Each criterion was rated using a 4-point Likert scale ranging from 1 (not appropriate) to 4 (very appropriate). The material expert gave a score of 97.9%, classifying the e-book as “*Very Eligible*”, particularly noting the strength of the educational content in conveying key disaster preparedness messages clearly and effectively to young children.

The media design expert highlighted the e-book’s appealing use of colors, graphics, and animations, which were considered suitable for attracting and maintaining children’s attention. However, the expert also suggested improving the symmetry of layout components and spacing between elements to enhance visual balance and readability. The language expert emphasized the importance of simplifying complex sentence structures and using conversational, familiar vocabulary to ensure that children could understand the story and instructions independently or with minimal adult assistance.

These suggestions were promptly incorporated into the revised version of the e-book. Layout elements were adjusted to improve symmetry and alignment, while instructional text and story narration were edited to better match the linguistic comprehension levels of children aged 4–6. These modifications not only improved the aesthetic quality of the e-book but also strengthened its pedagogical integrity by ensuring that the content could be both easily accessed and meaningfully understood by young learners.

The expert validation process played a critical role in refining the product before field testing. It ensured that the e-book was not only visually engaging and technically functional, but also educationally sound, developmentally appropriate, and aligned with best practices in disaster education for early childhood. The high score achieved during validation indicated that the e-book met the essential criteria for effective learning media and was ready for implementation in a classroom setting.

3.4 Trial Phase

A small-scale field test was conducted to evaluate the effectiveness of the interactive e-book in improving disaster preparedness knowledge among early childhood learners. The trial involved 12 children aged 4–6 years from PAUD Al Hidayah in Taman Sari, Subang. To ensure individualized attention and minimize distraction, the participants were divided into three rotating groups, each using the e-book in turns on school computers. This arrangement allowed the researcher and the teacher to guide children more effectively and observe their interactions closely during the learning session.

Before using the e-book, children completed a pretest consisting of 10 multiple-choice questions designed to assess their basic understanding of disaster types, warning signs, and appropriate response actions. The pretest results revealed limited prior knowledge, with an average score of 35.83 out of 100, indicating that most children were not yet familiar with structured concepts of disaster preparedness. Many struggled to differentiate between disaster types or identify correct safety behaviors.

Following the learning session using the interactive e-book, a posttest with similar question structure was administered. Results showed a significant improvement, with the average score rising to 72.5 out of 100. This nearly doubling of scores suggests that the multimedia and interactive elements of the e-book successfully enhanced children's understanding in a relatively short time.

In addition to the quantitative improvement, qualitative observations during the trial revealed high levels of engagement. Children demonstrated enthusiasm and curiosity while exploring the e-book's features, such as clickable animations, sound effects, and educational games. While some initially needed guidance on how to navigate the digital interface—especially those unfamiliar with using computers—they quickly adapted after brief instructions. By the second activity, most children could operate the e-book independently, clicking through pages, listening to narration, and responding to quiz questions.

Children responded particularly well to the animated disaster scenarios, which helped them visualize real-world situations like earthquakes, floods, and fires. For example, in one interactive activity, children were asked to choose the correct action during an earthquake (e.g., take cover under a table), and most were able to select the appropriate response after viewing the animation and receiving audio instructions. Teachers also noted improvements in children's ability to recall key steps during classroom discussions following the trial.

These results suggest that the e-book not only facilitated learning but also fostered active participation, an essential factor in early childhood education. The integration of visual, auditory, and kinesthetic learning modes helped bridge the gap between abstract concepts and concrete understanding—an important achievement for children in the preoperational stage of cognitive development. The findings affirm the e-book's potential as a powerful tool for enhancing disaster literacy in early learners.

Discussion

The findings of this study indicate that the interactive e-book significantly enhanced children's understanding of disaster preparedness. This is evidenced by the substantial improvement in posttest scores, which nearly doubled after the intervention. These results align with the study by Setiawan et al. (2020), which demonstrated that structured disaster education significantly improved young learners' readiness and confidence in responding to emergency situations. The improvement observed in this study confirms that targeted, age-appropriate instructional media can play a pivotal role in fostering early disaster awareness.

Moreover, the results support prior research on the value of digital learning media in early childhood education. Hadaya and Hanif (2019) found that interactive media increase student motivation, engagement, and comprehension, particularly in abstract or unfamiliar content areas. Similarly, Purnamasari and Wijayanti (2021) emphasized that digital storybooks and e-books provide enjoyable, multisensory experiences that promote cognitive and emotional development. The combination of sound, images, and interactive tasks in this study's e-book created a playful and immersive environment, helping children visualize disaster scenarios and internalize appropriate responses.

These findings are also theoretically grounded in developmental psychology. The instructional design was informed by Piaget's theory of cognitive development, particularly the characteristics of the preoperational stage (ages 2–7), during which children learn most effectively through symbolic play, visual aids, and concrete examples (Piaget, 2018). By integrating visual illustrations, animations, and

audio narration, the e-book translated abstract disaster preparedness concepts into tangible learning experiences that were developmentally appropriate.

Additionally, Vygotsky's sociocultural theory emphasizes the importance of scaffolded learning and social interaction in knowledge construction (Vygotsky, 2019). This was reflected in the collaborative learning environment created during the e-book sessions, where teachers provided guidance, and children engaged in peer learning. Although parental involvement was limited during this trial, the e-book's design offers potential for home-based learning, allowing parents to participate more actively in reinforcing disaster preparedness skills.

Despite the promising results, the study does have several limitations. The small sample size ($n=12$) and the single-institution setting limit the generalizability of the findings. Future research should involve larger and more diverse samples across multiple early childhood education centers to validate the broader applicability of the e-book. The short duration of the trial also restricts conclusions about the long-term retention of disaster preparedness knowledge. Longitudinal studies are needed to determine whether these early learning gains persist over time.

Another limitation was the children's initial unfamiliarity with digital learning tools. Some participants required extra support to navigate the e-book's interface, highlighting the need for more intuitive design features or introductory tutorials for first-time users. Future iterations of the e-book could include a simple onboarding guide or a verbal walkthrough to facilitate independent use, especially in less tech-integrated school environments.

Despite these constraints, the positive learning outcomes and high engagement levels observed during the trial suggest that the interactive e-book is a promising and scalable tool for early childhood disaster education. Its digital format allows for easy distribution, cost-effective updates, and broad accessibility, making it a viable option for both classroom use and home-based reinforcement. The potential to involve parents further enhances the tool's impact, promoting a shared responsibility for building disaster preparedness from an early age.

In conclusion, this study contributes to the growing body of evidence supporting the integration of technology-enhanced learning tools in early childhood education, particularly in the context of disaster risk reduction (DRR). The interactive e-book developed here not only improved knowledge but also supported the development of essential skills and confidence needed to respond to emergency situations. With further refinement and wider implementation, this tool can play a vital role in building a more resilient and disaster-aware generation from the earliest stages of education.

4. CONCLUSION

This study concludes that the development of an interactive e-book for early childhood disaster education provides a meaningful and effective medium for enhancing young children's understanding of disaster preparedness. Grounded in principles of cognitive development and supported by expert validation, the e-book demonstrated strong pedagogical value through its integration of visual, auditory, and interactive features tailored to the learning needs of children aged 4–6. The observed improvement in posttest scores, combined with high engagement levels during the trial, underscores the potential of digital media to facilitate concept acquisition in abstract domains such as disaster response.

The validation process affirmed the e-book's suitability in terms of content accuracy, visual appeal, and linguistic appropriateness. The implementation in a real classroom setting further confirmed that young learners, even with limited prior exposure to digital media, could adapt quickly and engage meaningfully when guided appropriately. These findings reinforce the argument for integrating disaster education into early childhood curricula through innovative, developmentally appropriate technologies.

Future studies should explore the long-term impacts of interactive e-books on children's behavioral preparedness, including their ability to retain and apply knowledge in emergency contexts.

Additionally, integrating such resources with other digital platforms—such as mobile learning applications, online learning management systems, or augmented reality tools—could expand accessibility and enhance the effectiveness of disaster education programs. Such advancements would contribute to building a more resilient generation from an early age, aligned with global goals for disaster risk reduction in education.

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