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Development of Disaster Mitigation Learning Media for Students with Intellectual Disabilities

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ABSTRACT

Indonesia is a disaster-prone country with a high population of vulnerable groups, including people with intellectual disabilities. The lack of disability-friendly disaster mitigation educational media makes them less prepared to face disasters. This research aims to develop an Android-based disaster mitigation learning application specifically for students with intellectual disabilities. The application, Edubencana, was developed with a visual approach and simple navigation to facilitate student understanding. The material in the application includes an introduction to disasters, mitigation strategies, and evaluation through quizzes. Content validation was carried out by special education teachers using the v-aiken index, obtaining valid results with a score of 0.72. Field trials were conducted on students with intellectual disabilities using the normalized gain hake method to observe changes in student understanding. The use of illustrations, simple language, and accessibility are key factors in the success of this media in conveying mitigation material effectively. This application can be an alternative, inclusive learning medium in disaster education in Indonesia.

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1. INTRODUCTION

Indonesia is one of the countries with the highest exposure to natural disasters. This vulnerability is closely linked to its geographical, geological, and climatic conditions, as well as its social and cultural diversity, which together shape the complexity of disaster risk across regions (Handoyo et al., 2023). Geographically, Indonesia is located at the convergence of major tectonic plates and along the Pacific Ring of Fire, while also containing numerous active fault systems, making the country highly prone to earthquakes, tsunamis, and volcanic eruptions (Siagian et al., 2014). These characteristics place Indonesia in a particularly fragile position in relation to natural hazards and make disaster preparedness a critical national concern (Alwin et al., 2020).

The scale of disaster occurrence in Indonesia also highlights the urgency of this issue. Over the past five years, the country has experienced tens of thousands of disaster events, with the highest annual number of incidents recorded in 2023. Such recurring disasters continue to cause material damage, disruption of social life, and, most importantly, loss of life. In this context, disaster risk reduction cannot be understood solely as an emergency response agenda, but must also be approached as a long-term educational and social responsibility. This is particularly important because disasters do not affect all groups equally. Among the most vulnerable are persons with disabilities, who often face greater difficulty in accessing information, mobility support, and safe evacuation during emergency situations (Maulita et al., 2023).

The vulnerability of persons with disabilities in disaster contexts has been widely acknowledged. According to the United Nations for Disaster Risk Reduction, persons with disabilities often experience disproportionately higher risks during disasters because they are frequently overlooked in preparedness planning and are not provided with sufficient knowledge, facilities, or accessible evacuation support (UNDDR, 2023). This condition indicates that disaster mitigation should not only focus on general populations, but also on ensuring accessibility, inclusion, and protection for vulnerable groups. Disaster mitigation itself includes efforts to reduce disaster risk through both structural and non-structural measures, such as disaster-resistant infrastructure and community education aimed at increasing awareness and preparedness (Edy et al., 2020). However, the implementation of such measures remains uneven, partly because of limited local governmental capacity in planning and executing disaster mitigation policies effectively (Butterworth-Heinemann, 2022).

In the Indonesian context, disaster education should be inclusive and equally accessible to all citizens, including vulnerable groups. Legal and policy frameworks have emphasized the rights of vulnerable populations to receive proper protection, disaster education, and information related to disaster management. These rights imply that persons with disabilities should receive the same degree of attention as others in disaster preparedness and mitigation education (Taklal et al., 2023). Nevertheless, the implementation of inclusive disaster education remains limited. In many cases, persons with disabilities are only provided with basic instructions, such as evacuation routes or identification procedures, rather than comprehensive learning about disaster signs, risks, and appropriate responses. This limitation weakens their ability to act independently and safely when disasters occur (Zulfiana et al., 2024).

Among persons with disabilities, students with intellectual disabilities require particularly careful educational support in disaster mitigation. Persons with intellectual disabilities often experience below-average intellectual functioning and limitations in adaptive behavior, which

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may affect their ability to process information, maintain attention, and respond appropriately in unfamiliar or threatening situations (Lontoh et al., 2019). In addition to cognitive challenges, they may also experience social and emotional difficulties, including unstable emotional responses, irritability, and difficulty engaging in abstract thinking, all of which may further complicate learning processes and emergency decision-making (Awalia, 2016). Because of these characteristics, disaster education for students with intellectual disabilities cannot rely on conventional instructional approaches. Instead, it must be designed in ways that are concrete, accessible, engaging, and tailored to their specific learning needs (Johan et al., 2022).

This need is closely related to the broader principle of inclusive education. Students with disabilities often face limitations not only in physical functioning but also in cognitive development, which requires the provision of educational services that are responsive to their conditions (Hilfi et al., 2023). Inclusive education is intended to provide all learners, including those with disabilities and those with special talents, with equitable opportunities to participate in meaningful educational processes alongside other students (Kementerian Pendidikan dan Kebudayaan, 2009). However, in practice, disaster mitigation education for students with disabilities in Indonesia remains insufficient and often ineffective due to limited learning materials, inadequate facilities, and the lack of specialized instructional support in schools (Nabilla Balqis & Hasibuan, 2024). This gap indicates the need for more appropriate learning media that can help bridge the accessibility barrier in disaster education for students with intellectual disabilities.

Learning media play a central role in this regard because they function as tools for delivering information in ways that can stimulate attention, support understanding, and make learning more meaningful. In educational settings, learning media are understood as intermediaries that help teachers communicate messages more effectively to students, thereby improving the clarity of content and increasing the likelihood that instructional goals will be achieved (Suparlan, 2020). They are also important for motivating students and supporting a more complete and meaningful learning process, particularly when learners require concrete and visually supported forms of instruction (Hasan et al., 2021; Nurrita, 2018). For students with intellectual disabilities, whose difficulties often include limited attention and challenges in understanding verbal or abstract information, visually engaging and interactive media are especially important. Media that incorporate images, simple navigation, and repeated exposure to content may help them maintain focus and understand essential concepts more effectively (Lontoh et al., 2019; Arifudin et al., 2024).

Based on this background, this study was conducted to support the advancement of inclusive disaster education by developing disaster mitigation learning media for students with intellectual disabilities in the form of an Android-based application. The study also aimed to examine the effectiveness of this learning media as an accessible and engaging educational tool for students with intellectual disabilities. By addressing the specific learning needs of this vulnerable group, the study was expected to contribute to more inclusive disaster preparedness efforts and to expand the role of digital learning media in special and inclusive education contexts.

2. METHOD

2.1 Research Design

This study employed a research and development approach to develop an Android-based disaster mitigation learning medium for students with intellectual disabilities. The

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development process followed the ADDIE model, which consists of five systematic stages: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was selected because it provides a structured instructional design framework for developing educational products in a learning environment (Weldami & Yogica, 2023). According to Branch (2009), ADDIE offers a systematic process for navigating the complexity of instructional material development and for ensuring that the resulting product is pedagogically appropriate and practically applicable.

At the analysis stage, the study identified the learning needs, instructional problems, and characteristics of students with intellectual disabilities in relation to disaster mitigation education. The output of this stage was a summary of the needs analysis that served as the basis for subsequent design decisions. At the design stage, the learning objectives, instructional content, interface structure, and activity flow of the application were planned, resulting in a design blueprint for the learning media. At the development stage, the Android-based application and supporting instructional materials were produced and prepared for validation. At the implementation stage, the developed application was introduced to the target users through a limited field trial involving students with mild to moderate intellectual disabilities. Finally, at the evaluation stage, the product was assessed both before and after implementation to determine its content validity and preliminary effectiveness as a learning medium for disaster mitigation.

2.2 Participants and Sampling

The population of this study consisted of students enrolled at SLB C Dharma Asri, Depok City, which served as the research site. In research methodology, a population refers to the entire group of subjects or objects that share specific characteristics relevant to the study, whereas a sample refers to a smaller subset selected to represent that population (Firmansyah & Dede, 2022).

This study applied purposive sampling, which allows researchers to select participants based on specific criteria relevant to the objectives of the study (Etikan, 2016). Four students were selected as the trial participants. The selection criteria included students with mild to moderate intellectual disabilities who were considered capable of participating in the limited trial of the Android-based application. The relatively small number of participants was due to the limited number of students who met the criteria and could be involved in the field testing stage of the product development process.

In addition to the student participants, nine raters were involved in the content validation stage. These raters consisted of individuals considered competent to assess the relevance and appropriateness of the developed media for the target users. Their evaluations were used to determine the content validity of the application before the field trial was conducted.

2.3 Instruments and Data Collection

This study used several instruments to collect data during the development and evaluation process. First, the developed application was subjected to content validation by expert raters. Content validation was conducted to assess the relevance, clarity, and appropriateness of the learning media for students with intellectual disabilities. The raters evaluated the product using a five-point relevance scale consisting of: 1 = very irrelevant, 2 = irrelevant, 3 = fairly relevant, 4 = relevant, and 5 = very relevant.

Second, the field trial involved the use of pre-test and post-test instruments to assess changes in students' understanding of disaster mitigation after using the application. The

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tests were administered using Google Forms, which functioned as the learning outcome measurement tool before and after the treatment. The use of pre-test and post-test data allowed the study to examine the instructional effectiveness of the developed media in improving students' understanding of disaster mitigation concepts.

2.4 Data Analysis

The data analysis in this study employed quantitative procedures. The results of the expert validation were analyzed using the Aiken's V index, which is a quantitative method used to estimate the degree of agreement among raters regarding the relevance of the items in an instrument (Aiken, 1985). The formula for Aiken's V is as follows:

$$V = \frac{\sum s}{n(c-1)}$$

where $s = r - lo$, r is the rating assigned by the rater, lo is the lowest possible rating, n is the number of raters, and c is the highest possible rating. The Aiken's V coefficient ranges from 0 to 1, with values closer to 1 indicating stronger content validity. In this study, nine raters were involved, and the minimum acceptable Aiken's V coefficient was 0.72, following Aiken's criteria for the number of raters used (Aiken, 1985).

To examine the effectiveness of the developed application, the pre-test and post-test scores from the student trial were analyzed using the normalized gain formula proposed by Hake (1998). The formula is presented as follows:

$$g = \frac{\text{post-test score} - \text{pre-test score}}{100 - \text{pre-test score}}$$

The normalized gain score was used to determine the degree of improvement in students' understanding after the intervention. The resulting scores were interpreted using the following criteria: high if $g \geq 0.7$, medium if $0.3 \leq g < 0.7$, and low if $g < 0.3$ (Hake, 1998). Through this analysis, the study sought to identify the extent to which the Android-based disaster mitigation learning media contributed to improving the understanding of students with intellectual disabilities.

3. RESULT AND DISCUSSION

3.1 Result

The development process began with the analysis stage, which identified the learning needs of students with intellectual disabilities and examined their academic and cognitive characteristics in relation to disaster mitigation learning. Interviews with the school principal and teachers indicated that the target learners generally had cognitive and academic capacities comparable to those of second-grade elementary school students. The findings also showed that these students responded more positively to learning materials containing many pictures, as visual representations helped them remember and understand the content more effectively. The analysis further revealed that disaster mitigation education for students with intellectual disabilities remained limited, as existing practice relied mainly on occasional outreach sessions delivered by external institutions and focused primarily on evacuation directions and basic safety information. Based on these findings, the study sought to develop

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a practical and continuously accessible learning medium that emphasized attractive illustrations and simple content presentation to support students' comfort and comprehension during learning.

The user interface was intentionally designed to be as simple as possible. Decorative elements were minimized to avoid distracting the users, while buttons were made visually prominent and clearly labeled. Cartoon-like illustrations were included to support students in imagining real disaster situations more concretely rather than relying only on verbal explanations. The main menu of the Edubencana application consisted of five submenus, namely Definition, Disasters Around Us, Disaster Mitigation, Quiz, and About.

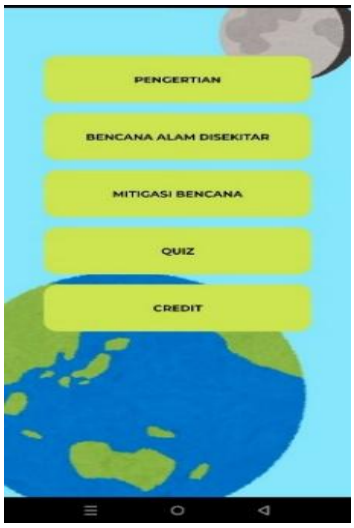

Figure 1. Screenshot of the Main Menu of the Edubencana Application



Figure 2. Screenshot of the Definition Menu of the Edubencana Application



Figure 3. Screenshot of the Definition Menu of the Edubencana Application



Figure 4. Screenshot of the Disasters Around Us Menu of the Edubencana Application



Figure 5. Screenshot of the Disaster Mitigation Menu of the Edubencana Application



Figure 6. Screenshot of the Quiz Menu of the Edubencana Application

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After the development stage, the Edubencana application was subjected to content validation by nine special education teachers who work with students with disabilities. The target validity threshold was set at V > 0.72. The validation focused on navigation, interface, typography, visuals, language, mitigation content, visual design, educational features, and supporting media.

Table 1. Validation Indicators of the Application

Component	Indicator	Item
Navigation and Interface	Menu navigation	1
Typography and Visuals	Readability of text size	2
Typography and Visuals	Clarity of image size	3
Navigation and Interface	Accessibility across menus	4
Language and Child-Friendly Language	Clarity of language	5
Language and Child-Friendly Language	Ease of language comprehension	6
Mitigation Material	Audio-visual media in the application	7
Visual Design	Application color contrast	8
Navigation and Interface	Simplicity of application navigation	9
Content Design	Clarity of information	10
Educational Features	Availability of quiz	11
Educational Features	Ease level of quiz	12
Educational Features	Language used in quiz questions	13
Supporting Media	Accessibility of YouTube videos	14
Supporting Media	Duration of learning videos	15

The validation data were collected using a Google Form questionnaire to facilitate efficient scoring and data collection. The Aiken's V analysis showed that 11 out of 15 items met the validity threshold, while 4 items fell below the required score.

Table 2. Validation Results

Item	V	Description
Item 1	0.75	VALID
Item 2	0.78	VALID
Item 3	0.78	VALID
Item 4	0.78	VALID
Item 5	0.75	VALID
Item 6	0.69	NOT VALID
Item 7	0.75	VALID
Item 8	0.75	VALID
Item 9	0.78	VALID
Item 10	0.78	VALID
Item 11	0.81	VALID
Item 12	0.69	NOT VALID
Item 13	0.67	NOT VALID
Item 14	0.69	NOT VALID
Item 15	0.75	VALID

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Overall, the validation results indicated that the instrument used to assess the Edubencana application had acceptable content validity. Although several items did not reach the expected threshold, the majority of the items were classified as valid, indicating that the application was generally considered feasible. The invalid items were treated as input for revision prior to wider implementation.

The field trial results showed that the disaster mitigation learning application attracted students' attention, especially through its illustrated content and text-based presentation that supported reading and comprehension. The trial involved four students with intellectual disabilities at a special school, assisted by a teacher to ensure that the testing process ran smoothly. Pre-test and post-test data were collected using Google Forms. The first trial produced the following results.

Table 4. Results of the First Trial

Name	Pre-test	Post-test
T	70	90
H	40	90
R	60	100
L	50	100

The first trial demonstrated a substantial increase in post-test scores for all four students following the learning intervention. The normalized gain analysis showed that Student T achieved a gain score of 0.67, Student H achieved 0.83, while Students R and L each achieved 1.00. Overall, these results indicate that the intervention produced moderate learning gains for one student and high learning gains for the remaining three students.

Based on these gain scores, three students reached the high category, while one student was in the medium category. These findings indicate that the learning media contributed positively to students' understanding of disaster mitigation material. A second trial was conducted to examine whether students' understanding improved further or declined after repeated use of the same learning application and the same Google Form instrument.

Table 5. Results of the Second Trial

Name	Pre-test	Post-test
T	70	100
H	80	100
R	70	90
L	90	100

The second trial also showed improvement in post-test performance, and the pre-test scores were generally higher than those in the first trial, indicating that the students retained knowledge from the previous learning session. The normalized gain analysis showed that Student T achieved a gain score of 1.00, Student H also achieved 1.00, Student R obtained 0.67, and Student L achieved 1.00. These results indicate that three students reached the high gain category, while one student remained in the medium gain category.

In the second trial, Students T and H improved to the high gain category with a score of 1.00. Student R, however, showed a decline from a gain score of 1.00 in the first trial to 0.67

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in the second trial, although this score still remained within the medium category. This decline appeared to be related to the student's lack of cooperation during the learning session, as Student R did not consistently follow instructions from the researcher and the assisting teacher and seemed to respond to the post-test less carefully. Nevertheless, the overall pattern across both trials still indicated positive learning gains following the use of the Edubencana application.

3.2 Discussion

The needs analysis showed that students with intellectual disabilities required visually supported, concrete, and easily accessible learning materials, and this result is consistent with the broader literature on inclusive disaster risk reduction education. Recent studies have shown that children with special educational needs and disabilities face disproportionately high risks during disasters because preparedness materials are often not adapted to their communication and learning profiles, which makes accessible disaster education a critical rather than optional intervention (Sheehy et al., 2024; Yamawaki et al., 2025). In the Indonesian context, disability communities have also been shown to experience structural barriers in disaster preparedness, including limited access to information and insufficiently inclusive support systems, which reinforces the importance of designing targeted educational responses for vulnerable learners (Setijaningrum et al., 2024; Susilana et al., 2022).

More broadly, disaster risk reduction education is increasingly recognized as most effective when it is integrated into educational practice through developmentally appropriate and context-sensitive learning materials rather than delivered only as occasional outreach activities, which is directly relevant to the rationale for Edubencana in this study (Tyas et al., 2025). These findings help explain why the analysis stage in the present study identified a practical gap between the need for disaster mitigation learning and the limited availability of media that are continuously accessible for students with intellectual disabilities.

The design choices made in Edubencana were also pedagogically relevant to the characteristics of the target learners. The use of simple navigation, large and visually salient buttons, explicit labels, reduced decorative distractions, and picture-supported content aligns with current evidence showing that inclusive digital learning environments are more effective when interfaces are intentionally simplified for students with disabilities and low literacy profiles (Navas-Bonilla et al., 2025; van Calis et al., 2025). This is particularly important for learners with intellectual disabilities, for whom digital accessibility depends not only on technical access but also on clarity of language, cognitive simplicity, and the ease with which information can be processed and acted upon (Murillo-Jiménez et al., 2025).

The decision to provide an offline Android-based format was likewise relevant because mobile technologies can widen access to learning in situations where connectivity is unstable, while still allowing repeated use and immediate retrieval of content in real-life contexts (Gumbheer et al., 2022; Navas-Bonilla et al., 2025). In addition, the combination of text, illustrations, and video was appropriate because inclusive digital pedagogy increasingly emphasizes multimodal design as a means of reducing barriers to understanding and participation for students with special educational needs (Basister et al., 2025; Johan et al., 2022). The majority of valid items in the expert review therefore suggest that the Edubencana prototype was not only technically workable but also conceptually aligned with current principles of inclusive educational design, even though several items related to language and supporting features still required revision through iterative refinement, which is typical in product development research (Säuberli et al., 2023; de Leonardis et al., 2025).

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The positive gains observed across the two trials indicate that Edubencana had promising instructional value as a disaster mitigation learning medium for students with intellectual disabilities. This pattern is meaningful because the application did not rely on a single channel of explanation, but instead combined visual support, simplified text, videos, and quiz-based reinforcement, all of which are known to support comprehension and retention for learners who require adapted materials. Research on students with intellectual disabilities has shown that adapted texts and explicit visual supports can significantly improve comprehension when content is made concrete and systematically scaffolded (Dessemontet et al., 2024; Säuberli et al., 2023). In mathematics and literacy education more broadly, visualizations and interactive visual multimedia have also been found to strengthen learning by reducing abstraction and helping students organize information more effectively, especially when they are used in structured interventions (Schoenherr et al., 2024; Dong et al., 2024).

The engaging function of app-based learning observed in this study is also in line with recent work showing that mobile and game-based formats can promote participation, motivation, and emergency preparedness skills when the content is personalized and interaction is made intuitive for learners with disabilities (Jacobs et al., 2023). In this sense, the gains recorded in the present study can be interpreted not merely as score improvement, but as an indication that disaster education becomes more learnable when the medium is adapted to the learner rather than expecting the learner to adapt to the medium (Frisch et al., 2025; de Leonardis et al., 2025).

At the same time, the fluctuation observed in one student's second-trial performance is also important because it shows that the effectiveness of a digital learning medium for students with intellectual disabilities cannot be understood as uniform across users. Learners with intellectual disabilities often display substantial variation in attention, self-regulation, task persistence, and responsiveness to instruction, which means that short-term performance can be influenced by situational behavior as much as by content difficulty (Melzer et al., 2024; Frisch et al., 2025). This helps explain why the presence of a teacher assistant remained important during the trial and why one learner's lower post-test consistency should not be interpreted simply as evidence of weak media quality. Instead, it highlights a familiar issue in inclusive educational technology: access to a well-designed tool does not eliminate the need for guided facilitation, repetition, and behavioral support during use (Navas-Bonilla et al., 2025; van Calis et al., 2025). From a development perspective, this result suggests that Edubencana already demonstrated pedagogical potential, but its effective use is likely to be strongest when accompanied by adult mediation and structured implementation procedures that match the learners' cognitive and emotional conditions (Melzer et al., 2024).

Taken together, the findings position Edubencana as a relevant product within development-based research on inclusive disaster education. The application addressed a real instructional gap identified during the analysis stage, demonstrated acceptable content validity at the expert level, and generated positive preliminary learning gains during limited field testing. These are important outcomes because recent scholarship has emphasized that disability-inclusive disaster education must move beyond generic awareness campaigns toward accessible, learner-centered, and contextually grounded educational tools that can be used repeatedly in everyday settings (Sheehy et al., 2024; Sheehy et al., 2025). The current findings also support the broader argument that disaster preparedness for children with disabilities should be embedded in educational practice and supported by teachers who are equipped with both inclusive pedagogical strategies and appropriate tools (Yamawaki et al.,

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2025; Lacher et al., 2024). In that sense, Edubencana does not only function as a learning application, but also as a prototype showing how disability-inclusive disaster mitigation can be operationalized through digital media in special education settings. The discussion therefore suggests that the main contribution of this development study lies in demonstrating that accessible visual design, simplified content, and interactive mobile delivery can work together to make disaster mitigation learning more feasible for students with intellectual disabilities, while also addressing a broader need for more inclusive and educationally grounded disaster preparedness in Indonesia (Tyas et al., 2025; Setijaningrum et al., 2024).

4. CONCLUSION

This study concluded that the Edubencana application was a feasible and effective learning medium for improving the disaster mitigation understanding of students with intellectual disabilities. The findings showed that the application supported positive learning gains across the field trials, indicating its potential to facilitate disaster education in a more accessible and engaging manner. Its simple interface, clear navigation, and attractive visual illustrations appeared to match the learning characteristics of students with intellectual disabilities and contributed to their participation and comprehension during the learning process.

At the same time, the study also indicated that further refinement is needed to strengthen the application and advance inclusive disaster education. Improvements in visual comfort, language simplification, and overall design attractiveness would make the application more responsive to the specific needs of the target users. More broadly, the findings highlight the importance of stronger involvement from government institutions, schools, and special education professionals in providing inclusive disaster mitigation education not only for students with intellectual disabilities, but also for other disability groups. In this regard, Edubencana offers an important foundation for the continued development of more adaptive and inclusive digital learning media in disaster education.

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