Bridging Accessibility Gaps in Disaster Education for Visually Impaired Learners Through Contextual Learning Media

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Abstrak: Disaster education in Indonesia often lacks inclusivity, particularly for students with visual impairments. This study investigates the learning needs and media preferences of visually impaired learners in three disaster-prone coastal regions of Aceh: East Aceh, Langsa City, and Aceh Tamiang. Using a qualitative descriptive approach, data were collected through interviews and audio-based questionnaires involving six visually impaired students, six teachers, school principals, and disaster education facilitators. Thematic analysis revealed four key findings: limited access to disaster education materials; strong preferences for audio storytelling, sound-based simulations, and tactile maps; low teacher preparedness; and weak institutional support. A visually centered curriculum, lack of training, and exclusion from drills were identified as major barriers. Most students had never participated in actual evacuation practices and relied solely on verbal explanations. These findings highlight an urgent need for multisensory, adaptive, and contextual learning tools tailored to the cognitive and sensory needs of visually impaired learners. The study contributes new insights for the development of inclusive disaster education policies and instructional strategies in high-risk areas. By addressing these barriers, disaster risk reduction efforts can become more equitable and effective for all children, regardless of disability.

Keyword: Disaster Preparedness; Inclusive Education; Multisensory Learning; Visually Impaired Learners.

Introduction

Aceh Province is widely recognized as one of the most disaster-prone regions in Indonesia. Its eastern coastal districts—East Aceh, Langsa City, and Aceh Tamiang—are highly exposed to earthquakes, tsunamis, floods, and coastal abrasion. The Aceh Provincial Disaster Risk Assessment (2020–2024) and BNPB's InaRISK platform classify these areas as high-risk zones that urgently require inclusive disaster preparedness efforts (Badan Nasional Penanggulangan Bencana (BNPB), 2020; BPBA, 2022). The geographical and socio-economic vulnerabilities in these regions necessitate targeted disaster education, particularly for vulnerable groups such as children with visual impairments.

According to the Aceh Open Data portal (Q1/2024), more than 500 individuals with visual impairments reside in these three districts, the majority of whom are of school age (5–18 years). Nevertheless, disaster education for visually impaired learners remains very limited. In both Special Needs Schools (SLB) and inclusive schools, disaster education is still predominantly delivered through visual formats such as posters, videos, and maps, without adaptation into tactile, Braille, or audio-based materials. The lack of accessible learning resources, combined with insufficient teacher preparedness, contributes to low engagement and limited comprehension among visually impaired students.

Persons with disabilities, including those with visual impairments, are a priority group in disaster

mitigation. Such groups require disaster knowledge to raise awareness of the hazards around them. Visually impaired individuals who lack this knowledge are at greater risk of becoming victims. This vulnerability is further heightened when they live in areas with high disaster exposure, such as Aceh Province, which is recognized as one of Indonesia's most disaster-prone regions. This condition is illustrated in the Disaster Hazard Potential Map of Aceh Province, which depicts the distribution of risks across its districts and municipalities.
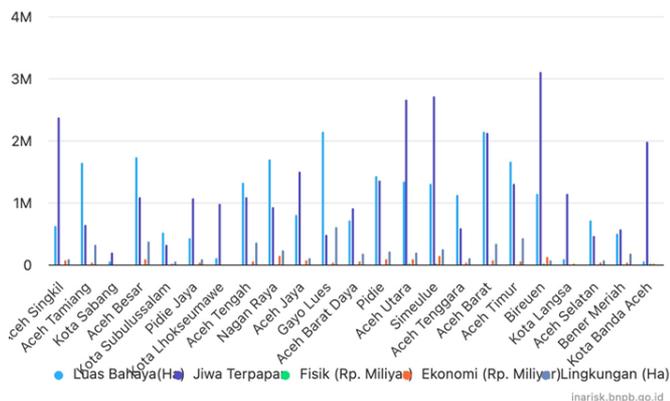
Figure 1. Disaster Hazard Potential Across Aceh Province (inarisk.bnpb.go.id)

Figure 1 illustrates the multidimensional disaster exposure across all districts and municipalities in Aceh Province, including hazard areas (in hectares), exposed population, physical damages (in billion rupiah), economic losses, and environmental impacts. Among all regions, East Aceh, Langsa City, and Aceh Tamiang—representing the eastern coastal corridor—are categorized as the most highly exposed. These districts record very high values across all indicators, particularly in terms of population exposure and physical risk, underscoring their vulnerability to multiple disaster types such as earthquakes, floods, and tsunamis.

Previous studies have emphasized the importance of adapting curricula and training to meet the specific needs of students with disabilities. Rofiah et al. (2023) highlighted the significance of inclusive disaster education supported by context-based teacher training and the use of adaptive learning tools (Samarakkody et al., 2023). Similarly, Efendi et al. (2009) as well as Smith and Roberts (2020) found that visually impaired learners demonstrate strong motivation and awareness of disaster risks, yet remain constrained by limited access to appropriate learning media and simulation activities, as most emergency information continues to be delivered in visual formats without accessible alternatives. This limitation stems from the fact that many disaster mitigation programs are not inclusively designed for persons with disabilities. In the case of

blind individuals, interventions often target their companions rather than the learners themselves (Benardi et al., 2024; Kurniawan, 2019). However, these studies did not identify which types of adaptive media are most effective, nor did they provide insights into students' direct responses and preferences.

In addition, schools within the study area generally lack adequate infrastructure to support multisensory learning for visually impaired students. Most disaster drills are designed for sighted learners, leaving visually impaired students as passive observers rather than active participants, which results in a lack of familiarity with evacuation routes during emergencies (Kharade et al., 2017). This gap in learning opportunities may heighten their vulnerability in real disaster situations (Rofiah et al., 2024).

This study seeks to fill these research gaps by identifying the most effective types of adaptive media to support visually impaired learners and by proposing patterns of multisensory learning tailored to their needs. Specifically, it analyzes the learning needs of visually impaired students in disaster education within the eastern coastal regions of Aceh. The study explores access barriers, preferred media types (tactile, audio, Braille), teacher preparedness, and institutional support (Handoyo, 2022; Ussarn et al., 2022). Through this approach, the research aims to integrate tactile simulations, audio storytelling, and guided experiential learning so that visually impaired students can participate more meaningfully in disaster preparedness education (Rofiah et al., 2024). The findings are expected to serve as a foundation for designing inclusive and contextually relevant disaster education curricula, enabling visually impaired learners to acquire knowledge effectively and respond with confidence in emergency situations.

Method

This study employed a qualitative descriptive design using a needs analysis approach. Harper et al. (2020) found that qualitative methods such as in-depth interviews provide significant insights into the specific needs of visually impaired individuals in understanding disaster mitigation. Further emphasized the importance of needs analysis in testing assistive technologies to evaluate their effectiveness within inclusive education contexts.

The research was conducted in three disaster-prone districts of Aceh Province—East Aceh, Langsa City, and Aceh Tamiang—which were selected due to their high exposure to natural hazards and the presence of inclusive schools and Special Schools (SLB) for students with disabilities.

Participants were selected purposively and consisted of six visually impaired students aged 10–17, six special education teachers, three inclusive school principals, three disaster education facilitators, and six parents of visually impaired learners. The inclusion of all stakeholders in the development of inclusive curricula is essential to ensure that the technologies implemented genuinely address the specific needs of students with visual impairments (Smith et al., 2020). Data were collected through semi-structured interviews and open-ended audio questionnaires adapted for visually impaired participants.

The collected data were analyzed using thematic analysis. Transcripts were coded and categorized to identify emerging themes related to learning barriers, preferred media formats (audio, tactile, Braille), and institutional support needs. This process informed the development of inclusive and contextually relevant disaster education strategies tailored for visually impaired students in the coastal regions of Aceh.

Table 1. Instruments and Indicators

Research Focus	Indicator	Instrument	Data Type
Learning Accessibility	Availability of non-visual materials (Braille, audio, tactile maps)	Interviews with students and teachers	Qualitative (narrative descriptions)
Media Preferences	Student-reported interest in specific media types	Audio questionnaire for students	Qualitative (verbal responses)
Teacher Preparedness	Teacher training and experience in disaster education for visually impaired students	Interviews with teachers and school principals	Qualitative (teacher experiences)
Institutional Support	School policies and resources for inclusive disaster education	Interviews with school principals and education officers	Qualitative (institutional narratives)

Results and Discussion

Thematic analysis of the interviews and audio questionnaires revealed four key findings: barriers to learning accessibility; preferred learning media; teacher preparedness; and institutional support gaps. Each of these findings is discussed in relation to relevant literature and the disaster context of the Aceh region.

Learning Accessibility Barriers

Visually impaired students in East Aceh, Langsa, and Aceh Tamiang reported limited exposure to disaster-related learning. None of the six student participants had ever taken part in a full evacuation drill, and all stated that most disaster education materials in their schools were delivered in visual formats—such as posters, videos, or diagrams—which they could not access.

This finding aligns with arguments that, while inclusive education is formally promoted, the implementation of inclusive disaster risk reduction (DRR) often remains superficial. The formal inclusion, where students with disabilities are present in school but are not meaningfully engaged in core pedagogical practices. The lack of adaptive DRR content prevents visually impaired students from internalizing hazard responses, further marginalizing them in disaster-prone areas.

Media Preferences and Multisensory Learning

When asked about the types of media that would help them learn more effectively, the majority of students identified audio storytelling (40%) and sound-based simulations (25%) as the most engaging formats. Tactile maps (25%) were also considered helpful, particularly for evacuation planning, while Braille texts were viewed as too technical and less engaging (10%).
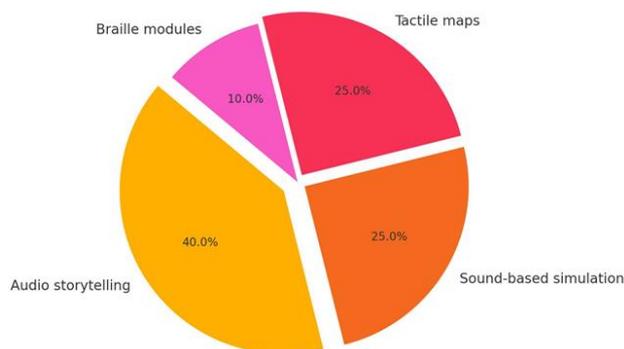
Figure 2. Preferred Disaster Education Media for Blind Student

Although Braille technology facilitates the understanding of evacuation routes and safety procedures among blind individuals (Kumar et al., 2024), these findings reinforce the need for multisensory approaches in disaster risk reduction (DRR) for students with visual impairments. Nikolaraizi et al. (2021); Raja & Narasimhan (2013) support this result, showing that multisensory information (audio and tactile) can reduce disaster risks for blind learners. Paivio's Dual Coding Theory further suggests that audio and tactile inputs can

significantly enhance conceptual understanding in the absence of visual cues (Morris, 2023). This supports the integration of storytelling, sound effects (e.g., tsunami sirens, floodwater audio), and tangible learning tools such as raised maps or textured hazard icons into disaster education modules. These strategies are further validated by Lillywhite & Wolbring (2022) who found that blind students respond more quickly when audio information is available.

In addition, media preferences are highly individual and shaped by students' exposure to digital tools. Those with prior experience using talking books or voice assistants demonstrated greater confidence and proactivity in proposing disaster scenarios and asking questions. Ha (2016)) found that voice narration effectively conveys evacuation instructions and hazard information. Confirmed that audio communication is more easily understood by blind individuals compared to text or visual media, while showed that voice technology in simulations significantly enhances preparedness by providing step-by-step evacuation guidance. These findings suggest that digital literacy and assistive technologies also play a vital role in raising ecological and risk awareness.

Teacher Preparedness and Pedagogical Gaps

Nearly all teachers interviewed acknowledged their lack of training in inclusive disaster education. While some had received general DRR materials from the Ministry of Education or the local disaster management agency (BPBD), none had encountered modules specifically adapted for visually impaired learners. Lesson delivery was predominantly verbal, lacking any visual-to-audio conversions, tactile materials, or customized simulations.

This lack of preparedness highlights the urgent need for capacity building, especially in high-risk zones such as Aceh. Teachers reported feeling isolated and "unqualified" to teach hazard response to students with disabilities—echoing Efendi et al.'s (2023) assertion that the main barrier to inclusive DRR is not reluctance, but the absence of clear pedagogical models and adaptive learning resources.

Institutional Constraints and Missed Opportunities

At the institutional level, schools lack inclusive standard operating procedures (SOPs) for emergency drills. Visually impaired students are often left out during simulations or are merely told to "stay with their seatmates" without proper guidance. There are no tactile evacuation maps, no audio announcements tailored for blind students, and no Braille versions of the school's emergency response plans.

This reflects a systemic issue in which policies exist but are poorly implemented. Melisa & Fadlan (2023) emphasized that effective disaster education must be both localized and accessible. Without structural adaptation, even schools committed to inclusion may fail. This situation is further exacerbated in rural areas of Aceh, where schools lack resources and administrators have limited access to national training programs.

From a disability rights perspective, this exclusion reflects what the Social Model of Disability defines as environmental and attitudinal barriers—where the problem lies not in the impairment itself, but in the lack of accommodation. By failing to adapt drills, communication channels, and learning materials, institutions reproduce vulnerability among visually impaired students.

Conclusion

This study highlights the urgent need for an inclusive disaster education model that addresses the specific needs of visually impaired students in coastal Aceh. The lack of adaptive learning media—such as audio simulations, tactile maps, and Braille-based materials—combined with untrained teachers and weak institutional support, significantly limits their disaster preparedness. Despite being among the most vulnerable, visually impaired students are often excluded from drills and practical simulations, thereby increasing their exposure to risks during actual emergencies. To bridge this gap, disaster education must be restructured using a context-based multisensory approach that empowers visually impaired learners to understand, respond to, and adapt to potential hazards. Developing inclusive media, enhancing teacher capacity, and integrating schools with local disaster management agencies are crucial steps to ensure that no child is left behind in times of crisis. These findings serve as a foundation for future research and policy innovation in inclusive disaster risk reduction education at both regional and national levels.

Author Contributions
Conceptualization, R.A.; methodology, F.I.A.; formal analysis, R.A.; writing—original draft preparation, R.A.; writing—review and editing, F.I.A. and Z.R.I.

Conflict of Interest

The authors declare no conflict of interest.

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