

BUILDING NATURAL DISASTER MITIGATION AWARENESS IN EARLY CHILDHOOD THROUGH VOLCANIC ERUPTION SIMULATION: A QUALITATIVE STUDY BASED ON EXPERIENTIAL LEARNING

Imam FAIZIN¹, Erni SUHARINI² and DIANA³

1 Postgraduate School, Semarang State University, Indonesia;
ifaizin@students.unnes.ac.id

2 Faculty of Social and Political Sciences, Semarang State University, Indonesia;
erni.suharini@mail.unnes.ac.id

3 Faculty of Education and Psychology, Semarang State University, Indonesia;
diana@mail.unnes.ac.id

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ABSTRACT

Disaster mitigation education for early childhood is a strategic effort to build risk awareness and preparedness from an early developmental stage, particularly in disaster-prone areas. This study aims to examine in-depth the disaster mitigation learning process through volcanic eruption simulations as a form of experiential learning for early childhood. The study used a qualitative approach with a descriptive design and was conducted at the Tunas Bangsa Kindergarten. Data were collected through participant observation, reflective interviews with educators and children, and documentation of learning activities. Learning activities included a volcanic eruption simulation using simple and safe materials, followed by demonstrations and practice of basic mitigation measures such as self-protection and evacuation behavior. Data analysis was conducted thematically to identify patterns of children's cognitive understanding, behavioral responses, and emotional regulation during the learning process. The results showed that multisensory simulations of natural phenomena helped children build an initial understanding of the concepts of danger, risk, and safety in a contextual manner. Children demonstrated active involvement, the ability to follow mitigation measures with functional understanding, and adaptive social-emotional responses without indications of excessive anxiety. The role of educators as mediators proved crucial in maintaining a balance between increasing risk awareness and children's emotional safety. This study confirms that experience-based disaster mitigation learning can be a meaningful pedagogical approach and is appropriate to the developmental characteristics of early childhood.

Keywords: Disaster Mitigation, Early Childhood, Experiential Learning, Volcano Simulation, Qualitative Research

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INTRODUCTION

Indonesia is a country known for its high vulnerability to natural disasters, due to its unique geographic, geological, and climatological conditions. Located at the confluence of three major tectonic plates: the Indo-Australian, Eurasian, and Pacific, Indonesia faces significant risks from various disasters, including earthquakes, volcanic eruptions, and tsunamis (Pramono & Kusumastuti, 2021). The presence of more than 128 active volcanoes makes the country one of the most vulnerable in the world to volcanic and seismic hazards (Inayah et al., 2020). Furthermore, climate change and human activities such as deforestation also influence the risk of hydrometeorological disasters, including floods and landslides (Ledyawati & Yuliani, 2019). To mitigate the negative impacts of these disasters, disaster mitigation has become a national strategic agenda, requiring a shift from post-disaster management to a prevention and risk reduction approach, including through continuous education (Yang et al., 2025). Indonesia has shifted its focus from post-disaster management to a prevention and risk reduction approach. These steps are crucial given the wide variety of risks faced by communities across regions, both urban and rural (Munadi & Fuady, 2021). Ongoing education on disaster mitigation is crucial, especially for communities living in disaster-prone areas. Knowledge of how to respond to disasters can increase community resilience and reduce the number of casualties and material losses caused by such disasters (Rimadeni et al., 2023; Dera, 2025).

To date, disaster mitigation education has focused primarily on adolescents and adults, with the assumption that young children lack the cognitive capacity to understand disaster concepts. This view is shifting with the development of early childhood education studies, which emphasize that children in early childhood are at a critical stage in developing attitudes, habits, and responses to disaster-affected environments (Ummah, 2025; Marta, 2025). Children in this group are the most vulnerable when disasters occur, but they also have great potential to be trained in disaster awareness and mitigation skills if learning is designed according to their developmental characteristics (Ningrum et al., 2025).

From the perspective of cognitive development theory, early childhood learns through concrete experiences, sensorimotor exploration, and direct interaction with the environment. According to Piaget, children in the sensorimotor and preoperational stages learn through physical and sensory exploration and social interaction (Zikrulloh et al., 2025). Research shows that sensorimotor activities taking place in natural environments can improve selective attention and short-term memory (Kolodzienski et al., 2025). Furthermore, teaching that involves direct experience tends to be more effective for children than abstract or verbal methods (Xue, 2025). In addition to cognitive aspects, emotional aspects are also important considerations in early childhood disaster mitigation education. The topic of disasters has the potential to instill fear if not presented carefully. Disaster narratives that emphasize damage and loss of life without appropriate pedagogical support can trigger anxiety and even trauma in children. Therefore, the main challenge in early childhood disaster mitigation education is not only raising risk awareness but also maintaining children's emotional safety throughout the learning process.

In the context of disaster mitigation learning, natural phenomena are often simplified through symbols, images, or stories, without actively involving children in the process of exploring the causes and effects of disasters. However, understanding disasters is not only about what to do when a disaster occurs, but also about how children understand that disasters are part of a natural phenomenon that has specific processes and can pose risks if not addressed appropriately. This limitation indicates a research gap in developing a more exploratory and experience-based disaster mitigation learning model.

One form of experiential learning with potential for disaster mitigation education is the simulation of natural phenomena. Simulations allow children to observe simple representations of natural events in a concrete and safe manner. Through simulations, abstract concepts can be realized in visual forms and multisensory experiences that are easily understood by children.

Simulations also provide space for children to ask questions, explore, and discuss their experiences with educators and peers.

The phenomenon of volcanic eruptions is a highly relevant context for disaster mitigation education in Indonesia. Volcanic eruptions have strong visual characteristics and are easily represented through simple simulations using materials that are safe and familiar to children. Through volcanic eruption simulations, children can observe visual changes, lava flows, and the resulting impacts, thus helping them develop an initial understanding of the concepts of hazard and risk.

More than simply introducing natural phenomena, volcanic eruption simulations can serve as a gateway to meaningfully introducing disaster mitigation measures. When children understand that volcanic eruptions can pose a hazard, they are more likely to understand the reasons why self-protection and evacuation are necessary. Thus, simulations of natural phenomena serve as a cognitive foundation that strengthens the internalization of mitigation measures.

Based on this mapping, this research occupies an important niche in the study of early childhood disaster mitigation education. The novelty of this research lies in the exploration of volcanic eruption simulations as an experiential learning medium observed through a qualitative approach. This research does not attempt to measure learning effectiveness, but rather examines how the learning process occurs, how children interpret their experiences, and how their cognitive, behavioral, and emotional responses are formed during the activity.

Theoretically, this research contributes to strengthening the application of constructivism theory and experiential learning in the context of early childhood disaster mitigation education. Practically, this research provides a reference for early childhood education educators in designing contextual, safe, and meaningful disaster mitigation learning. Thus, disaster mitigation education is positioned not as a frightening additional material, but as an integral part of thematic learning that supports children's holistic development.

LITERATURE REVIEWS

Disaster Mitigation Education for Early Childhood

Disaster mitigation education is part of a disaster risk reduction framework that aims to build individual awareness, preparedness, and adaptive capacity from an early age. Preparedness itself is a crucial stage in the disaster management process (Devina et al., 2024). Education plays a vital role in building public understanding of disaster risks by providing accurate, systematic, and educational information. Through disaster education, the public is taught to recognize various types of disasters, both natural disasters such as earthquakes, floods, and volcanic eruptions, as well as non-natural and social disasters such as fires, industrial accidents, or social conflicts.

From an educational perspective, disaster mitigation is not simply defined as mastering technical knowledge, but rather as a learning process that helps students understand environmental risks and develop appropriate safety behaviors. Several studies confirm that disaster education provided from an early age contributes to the development of long-term awareness and preparedness (Yildiz et al., 2023). Previous research shows that young children are able to understand basic safety and hazard concepts if learning is designed according to their developmental stage (Kholisoh & Aprilina, 2023). Studies on disaster education in early childhood education (PAUD) indicate that concrete, contextual, and activity-based approaches are more effective than purely verbal or narrative approaches. Disaster mitigation education for early childhood is also reported to be less traumatic when delivered through an emotionally safe approach and mediated appropriately by educators.

However, most previous research still emphasizes procedural aspects, such as evacuation drills or emergency response simulations. These approaches are important but risk producing a mechanical understanding if they are not accompanied by meaningful understanding of the

disaster phenomenon itself. Therefore, studies are needed that explore how young children develop an understanding of disaster mitigation through deeper and more meaningful learning experiences.

Early Childhood Development Theory and Its Implications for Disaster Education

Cognitive development theory provides an important foundation for designing disaster mitigation education for early childhood. According to Piaget, early childhood is in the sensorimotor and preoperational stages, where thought processes are still heavily dependent on concrete experiences and visual representations. Children understand the world through direct interaction with objects and the environment, as well as through observing simple cause-and-effect relationships. Abstract concepts such as risk and danger are difficult to grasp when presented symbolically or verbally (Shabnam et al., 2025) and (Hugar et al., 2017).

Furthermore, Vygotsky's sociocultural development theory emphasizes the role of social interaction and adult guidance in children's learning. The concept of the zone of proximal development suggests that children can achieve higher levels of understanding through the guidance of educators (Zhou, 2024; Bernard, 2024). In the context of disaster mitigation education, the role of teachers is crucial in helping children make sense of their learning experiences while maintaining their emotional safety.

Previous research has shown that delivering disaster material that does not take into account children's developmental characteristics has the potential to trigger fear or anxiety. Conversely, an approach aligned with children's developmental stages, using simple language and concrete experiences, actually helps children build a sense of security and self-confidence (Li & Zhou, 2021). This finding confirms that disaster mitigation education for early childhood must be designed with high sensitivity to children's cognitive and emotional aspects.

Experiential Learning and Constructivism: Previous Research Findings

Experiential learning and constructivism theory are widely used as foundations in early childhood education. Constructivism views knowledge as the result of active individual construction through experience and social interaction. Children do not passively receive knowledge, but instead construct understanding based on lived experiences and existing knowledge schemas (Jing, 2017).

Kolb explains that learning occurs through a cycle of concrete experience, reflection, conceptualization, and application. Although this theory is widely applied to adult learners, its basic principles are also relevant for early childhood with certain adjustments. Previous research has shown that experiential learning can increase children's engagement, attention, and understanding of abstract concepts (Navrátilová & Puhrová, 2017; Nhung et al., 2022).

In the context of disaster mitigation education, several studies report that experiential learning helps children understand the rationale behind safety measures. Children not only know what to do but also understand why those actions are important (Yamamoto, 2020; Liu et al., 2017). This approach is considered more meaningful than learning that only emphasizes memorization or procedural practice. These research findings strengthen the argument that disaster mitigation education needs to be linked to real-life experiences and age-appropriate reflection.

Natural Phenomenon Simulations in Early Childhood Disaster Mitigation Education

Natural phenomenon simulations are an experiential learning strategy widely used in early childhood science and disaster education. Simulations allow children to observe simple representations of natural events in a safe and controlled environment. Previous research has shown that simulations and educational games can increase children's engagement and help them understand cause-and-effect relationships concretely (Pranata, 2024).

Several studies on disaster education report that disaster simulations, such as earthquakes or floods, can increase children's preparedness without inducing fear when delivered with an appropriate approach (Yildiz et al., 2023; Krnjić & Cvetković, 2021). However, most of this research focuses on emergency response simulations, rather than exploring the natural

phenomena underlying disasters. As a result, children's understanding of the concept of risk is often superficial.

Volcanic eruption simulations hold great potential in this context because these phenomena have a strong visual character and are relevant to disaster situations in Indonesia. Through simple simulations, children can observe the eruption process and understand that certain natural phenomena can pose a hazard. When this understanding of natural phenomena is linked to mitigation measures, children more easily interpret safety behaviors contextually.

It is important to emphasize that simulations in early childhood education are learning strategies, not experiments in the quantitative methodological sense. The primary focus of simulations is on children's learning processes and experiences. Therefore, a qualitative approach is relevant to examining how simulations of natural phenomena help children develop an understanding of disaster mitigation, risk awareness, and emotional regulation. This limitation of studies integrating simulations of natural phenomena with disaster mitigation education forms the basis and position of this research.

RESEARCH METHODOLOGY

This study used a qualitative approach with a descriptive design to examine the learning process of natural disaster mitigation in early childhood. This approach was chosen because the research focused on understanding children's learning experiences, pedagogical processes, and cognitive, behavioral, and socio-emotional responses that emerge during learning activities, rather than on measuring effectiveness or quantitatively testing the effects. The volcanic eruption simulation was positioned as an experiential learning strategy observed naturally in the context of early childhood learning.

The study was conducted at the Tunas Bangsa Kindergarten (KB Tunas Bangsa) with participants from all early childhood children involved in routine learning activities. Children were included without being divided into treatment or control groups. Educators served as key informants, providing reflections on the learning process and children's responses.

Learning activities included a volcanic eruption simulation using simple and safe materials, followed by demonstrations and practice of basic mitigation measures such as self-protection and evacuation behavior. Data were collected through participant observation, reflective interviews with educators and children, and documentation of activities.

Data analysis was conducted using descriptive qualitative methods, grouping findings and drawing thematic meanings. Data validity was maintained through triangulation of sources and techniques, as well as reflective discussions with educators. All research activities are carried out with due regard to the ethical principles of child research, ensuring a safe, enjoyable learning environment that does not cause psychological stress.

RESEARCH RESULTS

The results of this study are presented based on field findings obtained through participant observation, reflective interviews with educators, and documentation of disaster mitigation learning activities based on a volcanic eruption simulation. The presentation of the results focuses on the learning process and responses of early childhood children, encompassing cognitive, behavioral, and socio-emotional aspects. The findings are organized thematically to illustrate how children interpret their learning experiences, rather than to quantitatively measure learning outcomes.

Children's Engagement in the Volcanic Eruption Simulation

Observations indicate that the volcanic eruption simulation significantly captured children's attention and engagement. From the initial stages of the activity, children demonstrated a strong interest in the simulation media used. This engagement was evident in the children's relatively

stable attention, enthusiastic expressions, and spontaneous questions and comments throughout the simulation.



Figure 1. Simulation Play Activity of a Volcanic Eruption

Children actively observed visual changes occurring in the simulation media, such as the appearance of foam analogous to "lava," color changes, and flows resembling eruptions. Their verbal responses demonstrated that they were not only observing but also attempting to interpret the observed phenomena. Phrases such as "hot," "erupting," "dangerous," and "don't go near" emerged spontaneously, indicating the formation of initial associations between the eruption phenomenon and potential risks.

Multisensory engagement was a crucial factor in capturing children's interest. Children not only observed but also approached, pointed, and discussed what they observed with their peers. These interactions demonstrated that the simulation functioned as a cognitive and social stimulus that encouraged children to actively engage in the learning process. These findings demonstrate that simulations of natural phenomena have a strong intrinsic appeal for young children and can create a lively and meaningful learning environment.

Children's Understanding of the Concept of Hazard and Disaster Risk

Through the volcanic eruption simulation, children began to develop an initial understanding of the concepts of hazard and risk associated with natural disasters. This understanding does not emerge through formal definitions, but rather through simple language and concrete representations appropriate to the child's developmental stage.

Observations show that children are able to identify volcanic eruptions as unsafe and potentially dangerous events. This is reflected in statements by children who describe eruptions as "hot," "shouldn't be touched," or "must stay away." These statements indicate that children are beginning to understand the cause-and-effect relationship between natural phenomena and the potential dangers they pose.

Children's understanding is also evident in changes in behavior during the activity. Children show caution when asked to approach the simulation media and follow the teacher's instructions to maintain distance. This behavior indicates that risk awareness is beginning to develop, although still at a concrete and contextual level. Children do not simply imitate the teacher's behavior but demonstrate a functional understanding of the reasons behind such behavior.

These findings suggest that simulations of natural phenomena act as a cognitive bridge, helping children understand abstract concepts such as danger and risk through concrete experiences. The understanding developed through these direct experiences provides an important foundation for the introduction of disaster mitigation measures at a later stage.

Children's Responses to Demonstrations and Practice of Mitigation Measures

Following the volcanic eruption simulation, the learning activity continued with demonstrations and practices of disaster mitigation measures. Observations showed that most

children were able to follow the teacher's instructions well and demonstrated an understanding of the objectives of the actions taken.

Children practiced self-protection measures and basic evacuation behaviors with enthusiasm and full participation. When asked to perform certain movements, children not only imitated them mechanically but were also able to explain simply the reasons behind the actions, such as "to be safe" or "to avoid harm." This indicates that the children's mitigation actions were based on the contextual understanding developed through the previous simulation.

The integration of natural phenomenon simulations and mitigation demonstrations has been shown to strengthen the quality of children's responses. Children who understood that volcanic eruptions are dangerous demonstrated greater levels of compliance and readiness in following mitigation procedures. These responses demonstrate the link between conceptual understanding and practical skills in the context of early childhood disaster mitigation education.

Furthermore, children demonstrated increased confidence during the mitigation practices. They appeared confident in performing the movements, reminding their peers, and following the teacher's directions in an orderly manner. These findings indicate that experiential disaster mitigation learning not only builds knowledge but also supports the development of children's attitudes and social skills.

Children's Social-Emotional Responses and the Role of Educators

Social-emotional aspects were an important focus of this study, given the potential for disaster topics to trigger anxiety in early childhood. Observations showed that during the learning activities, the children did not show signs of excessive anxiety such as crying, avoiding, or refusing to participate. Instead, they appeared calm, enthusiastic, and enjoying the activities.

This stable emotional state is inseparable from the role of educators in mediating learning. Educators consistently use calming language, provide explanations in a positive tone, and ensure that the simulation is understood as a learning activity, not a real, dangerous situation. Educators also provide positive reinforcement for children's participation and respond to children's questions patiently and empathetically.

Social interactions between children during the activity also show positive developments. Children share observations, collaborate on mitigation practices, and demonstrate empathy for their peers. These responses demonstrate that disaster mitigation learning not only fosters individual preparedness but also fosters collective awareness and social responsibility from an early age.

Reflective interviews with educators corroborate the observation findings. Educators reported that the simulation approach helps children understand the concept of hazard without instilling fear and makes it easier for educators to explain mitigation measures contextually. Educators also found that children become calmer and more confident than when disaster material is presented through stories or purely verbal explanations.

DISCUSSION & CONCLUSION

The results of this study indicate that volcanic eruption simulations are a meaningful experiential learning approach in disaster mitigation education for early childhood. Children's active engagement during simulation activities indicates that concrete, multisensory experiences can capture their attention and facilitate the natural construction of knowledge. This finding aligns with the theoretical view that early childhood learns most effectively through direct experiences involving multiple senses, particularly during the preoperational stage of development (Wardani, 2022; Pakpahan & Saragih, 2022; Nabilah et al., 2024).

Through simulations, children can observe representations of natural phenomena that were previously abstract. Visual changes and direct interaction with learning media help children construct mental images of volcanic eruptions as potentially hazardous events. This process

demonstrates how sensory experiences play a foundation for developing early cognitive understandings of risk and safety. Children are not merely recipients of information but actively ask questions and express their understanding in simple language, demonstrating early reflection and pedagogical dialogue.

Children's understanding of disaster mitigation concepts develops gradually through observation, everyday language, and contextual behavioral responses. Verbal expressions such as "hot," "danger," and "don't get close" reflect the process of assimilating new experiences into children's existing cognitive schemas. Furthermore, children's ability to explain the rationale behind self-protection and evacuation measures demonstrates that learning does not stop at the procedural level but develops into meaningful functional understanding. Integrating natural phenomenon simulations with disaster mitigation practices has been shown to help children connect knowledge with action more holistically.

This approach emphasizes the importance of integrating learning about natural phenomena with disaster mitigation education. By first understanding the process of a disaster, children more easily interpret safety measures as necessities, not simply instructions to be followed. Disaster mitigation learning is thus understood as a holistic process that connects cognitive, psychomotor, and affective aspects in an integrated manner, as emphasized in the principles of experiential learning.

From a socio-emotional perspective, this research shows that disaster mitigation learning does not cause excessive anxiety in early childhood when mediated appropriately by educators. The use of calming language, the avoidance of frightening narratives, and the emphasis that simulations are safe learning activities play a crucial role in maintaining children's sense of security and self-confidence. These findings confirm that the success of disaster mitigation education for early childhood depends heavily on the role of educators as facilitators and guardians of children's emotional well-being.

Overall, this research reinforces the view that disaster mitigation education for early childhood should be understood as an experience-based pedagogical process, rather than as a quantitative measure of effectiveness. Volcanic eruption simulations have proven relevant as a safe, meaningful, and developmentally appropriate learning context for children. This approach not only builds risk awareness but also fosters children's understanding, adaptive attitudes, and psychological readiness to face potential disasters in their environment.

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