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Enhancing Flood Disaster Resilience in Early Childhood Education through Interactive Learning

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Abstract

This community service initiative seeks to rectify the deficiency of thorough Disaster Risk Reduction (DRR) education for preschoolers in Indonesia, especially in flood-prone regions like Sragen, adjacent to the Bengawan Solo River. This service seeks to deliver effective and age-appropriate introductions to enhance early childhood flood awareness and preparedness. This service employs Participatory Action Research (PAR) to execute the community service program at TKIU Birrul Walidain Muhammadiyah Plupuh. This curriculum encompasses interactive learning activities, including evacuation simulations, educational games, and storytelling, to instruct children about flood preparedness. This program focuses on preschoolers aged 4 to 6 years, aiming to enhance their comprehension of disaster risks, safety protocols, and emotional control in situations. This curriculum effectively engaged children, leading to heightened awareness and comprehension of disaster preparedness. Observational data indicated that youngsters engaged actively in the simulations and activities, exhibiting enhanced comprehension of safety concepts and protocols. Pre-test and post-test outcomes demonstrated a substantial enhancement in children's comprehension of disaster categories and self-rescue techniques. Community service incorporating interactive game-based disaster risk reduction teaching was successful for toddlers in Indonesia. This underscores the necessity of incorporating disaster risk reduction education into early childhood curricula, continuous teacher training, and community involvement to cultivate a culture of safety. Future community service should prioritize the enduring effects of educational interventions on children's awareness and conduct concerning catastrophe preparedness.

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INTRODUCTION

Floods are among the most frequent natural hazards in Indonesia and pose serious risks to vulnerable populations, particularly young children (Ningrum et al., 2024; Prakosha; et al., 2024). Flood events in this area often disrupt daily activities and educational services, including early childhood education institutions located near the riverbanks. For children aged 4–6 years, flood hazards present heightened risks because of their limited physical abilities, developing cognitive capacities, and strong dependence on adults for guidance and protection during emergencies (Hia et al., 2021; Ningrum et al., 2024; Salam et al., 2025; Sharma et al., 2016).

Early childhood represents a critical developmental stage in which children begin to recognize their surroundings, follow instructions, and form basic behavioral patterns. In disaster situations, limited preparedness at this stage may increase the risk of physical harm and psychological distress. Previous studies indicate that disaster exposure without adequate preparation can lead to fear, confusion, and long-term emotional effects among young children, emphasizing the importance of introducing DRR education early in life (Rahiem & Rahim, 2020; Sharma et al., 2016).

Despite the growing emphasis on DRR in national and international policy frameworks, its implementation in early childhood education remains limited. Most school-based DRR programs focus on primary and secondary education, while structured DRR initiatives for preschool children are still underdeveloped. Additionally, DRR education frequently does not concentrate on flood risk, even in regions where flooding is the primary threat. Current research indicates a methodological deficiency, as numerous community-based DRR initiatives depend on descriptive narratives without offering systematic evaluation data to illustrate learning outcomes or behavioral modifications (Imam et al., 2025; Nurisusilawati & Rachmawaty, 2023).

Another limitation in the literature concerns the lack of empirical evidence on how preschool children respond to different DRR learning approaches (Onggo Cahyo et al., 2023; Windiani, 2021; Yani et al., 2023). Although several studies suggest that young children are capable of understanding basic disaster concepts, few provide measurable data or structured observations to support these claims, particularly in flood-prone settings such as the Bengawan Solo region (Septyandy et al., 2025; Sharma et al., 2016). This community service points out the value of studies that document not only program implementation but also data-based outcomes of DRR education tailored to early childhood. From a pedagogical perspective, play-based learning, simulations, and storytelling are widely recognized as appropriate approaches for children aged 4–6 years. Research in early childhood education demonstrates that children learn more effectively through active participation, hands-on experiences, and narrative-based instruction than through abstract explanations (Pyle & Danniels, 2017; De Angelis et al., 2019). In the context of flood DRR, these approaches enable complex risk concepts to be translated into simple and concrete actions, such as recognizing warning signs, following evacuation routes, and identifying safe locations.

This article meets this need by showing a case study of a community service program at TKIU Birrul Walidain Muhammadiyah Plupuh, Sragen, that taught preschoolers about flood mitigation and preparedness. This community is close to the Bengawan Solo River and is at risk of real floods. The program's goal was to explain how the implementation went and look into how effective interactive learning methods—like evacuation simulations, educational games, and storytelling—were thought to be at raising young children's awareness of floods and basic preparedness skills. The importance of this study is that it adds to the practical knowledge base for DRR in early childhood education in

Indonesia. It shows how to use methods that are both effective and fun, which could be used in other communities that are likely to have disasters.

Simulation-based activities provide experiential learning opportunities that support the development of procedural memory and basic response skills (Salam et al., 2025; Utama et al., 2024; Winangsih & Kurniati, 2020). Educational games reinforce recognition and recall through repetition and interaction, while storytelling helps children discuss disaster-related topics in a non-threatening manner and supports emotional regulation (Rahiem & Rahim, 2020; Riswanto & Soraya, 2022). Previous studies have shown that these approaches can improve disaster awareness and preparedness among preschool children when adapted to their developmental stage (Sharma et al., 2016; Sitepu et al., 2024).

Based on these considerations, this study aims to examine the implementation of education on reducing flood disaster risks for preschool children in a flood-prone area along the Bengawan Solo River. Specifically, the study documents a community service program conducted at TKIU Birrul Walidain Muhammadiyah Plupuh, Sragen, focusing on interactive learning activities, including evacuation simulations, educational games, and storytelling. Using a Participatory Action Research (PAR) approach, the study integrates structured observations, visual documentation, and pre-test and post-test assessments to evaluate children's understanding, response abilities, self-rescue awareness, and emotional regulation related to flood preparedness (Intyaswati et al., 2025; Safitri et al., 2024). This study contributes in three ways. First, it provides empirical evidence on the outcomes of flood DRR education in early childhood settings. Second, it presents a practical model of community-based DRR education that may be replicated in other flood-prone areas. Third, it demonstrates the relevance of PAR as a methodological framework for evaluating disaster education programs involving young children and local educational stakeholders.

METHODS

This community service project utilized the PAR methodology to enhance flood DRR education in early childhood environments. PAR was selected due to its focus on participatory engagement, iterative learning, and contextual problem-solving, rendering it especially appropriate for community-based disaster education in at-risk regions (Hildayanti & Machrizzandi, 2022; Muhtarom, 2018; Rahmat & Mirnawati, 2020). In community service settings, PAR facilitates collaboration among researchers, educators, and local stakeholders to identify issues, devise strategies, execute interventions, and evaluate results in an ongoing cycle (Hildayanti & Machrizzandi, 2022). The PAR procedure in this program comprised four interrelated stages.

Initially, participatory problem identification was executed via informal discussions and needs assessments with educators and school administrators to comprehend local flood risks associated with the Bengawan Solo River, children's previous exposure to disaster education, and current preparedness practices at the school level. This phase guaranteed that the intervention was based on the actual vulnerabilities and educational requirements of the community. Secondly, participatory action planning entailed collaboratively developing flood-centric disaster risk reduction educational activities that were suitable for various age groups (Chandrasari et al., 2025; Goma et al., 2022). With non-threatening practicality and consistency with early childhood education principles, educators engaged in establishing learning objectives, methodologies, and resources. The action implementation phase occurred at TKIU Birrul Walidain Muhammadiyah Plupuh, Sragen Regency, Central Java, involving 25 preschool students aged approximately 4 to 6 years, from January to March 2025. The implementation comprised a sequence of interactive educational activities designed to introduce fundamental flood preparedness concepts. The activities encompassed safe evacuation simulations, wherein children were instructed to

identify basic flood warning signs, adhere to specified evacuation routes, and proceed to secure assembly points; educational games aimed at enhancing disaster awareness and suitable response behaviors; and imaginative storytelling sessions utilizing visual media and puppetry to convey messages regarding flood safety, bravery, and communal support. The activities were intentionally crafted to be engaging and playful, alleviating fear while enhancing experiential learning.

Eventually, reflection and evaluation were performed as a fundamental component of the PAR cycle. This phase focused on assessing the implementation process and the perceived outcomes of the program. Data were gathered via document analysis of the community service proposal and progress reports, alongside structured observations conducted by the implementation team during educational activities. Observations concentrated on children's engagement, understanding, and reaction to flood preparedness communications. The reflective process facilitated the identification of effective practices and areas needing enhancement, offering feedback for educators and guiding the improvement of future DRR education programs. The structured PAR process illustrates how participatory and iterative methods can improve the efficacy of flood disaster risk reduction education for young children in disaster-prone regions (Mayla et al., 2025), especially those adjacent to the Bengawan Solo River.

This community service took place at TKIU Birrul Walidain, an integrated Islamic kindergarten in Plupuh District, Sragen Regency. This area is considered at risk due to its proximity to the Bengawan Solo River. Preschoolers who attended the school during the program (January to March 2025) were the participants. The survey did not provide exact figures, but for early childhood, children are typically around 4 to 6 years old.

The intervention consisted of a series of educational workshops provided over three months, aiming to explain flood catastrophe mitigation and preparedness ideas using engaging, age-appropriate ways. The progress report said that the main parts were

1. Safe Evacuation Simulation: Kids learned about common natural catastrophes (such as floods and earthquakes) and how to spot simple warning signs. They practiced fundamental safety responses, such as sheltering under tables (for earthquakes) and following designated evacuation routes to a safe assembly point during guided simulations. The emphasis was on making the simulation interactive and non-frightening, reinforcing learning through direct practice.
2. Educational Games: A number of games were used to help students remember what they had learned. Some examples might include matching games (like matching warning signs to disasters), board games on how to get out of a situation, or exercises about how to put together a simple emergency pack.
3. Creative Storytelling: Stories about catastrophe safety, bravery, and assisting others in an emergency were told in interesting ways, such as using puppets or pictures, to get important points across.

These fun exercises were meant to help people learn about disaster risks and fundamental safety rules.

The main sources of data for this case study were the community service proposal and the progress report. The program's documentation contained built-in ways to collect data, such as: (1) Document Analysis: The proposal and progress report gave information about the program's goals, scheduled activities, budget, participants, location, and reported outcomes and literature. (2) Observation: conducted by the implementation team during the activities, documenting children's involvement, comprehension, and participation in simulations and games, both during and after the program. The study of the implementation of the flow procedure is shown in Figure 1.

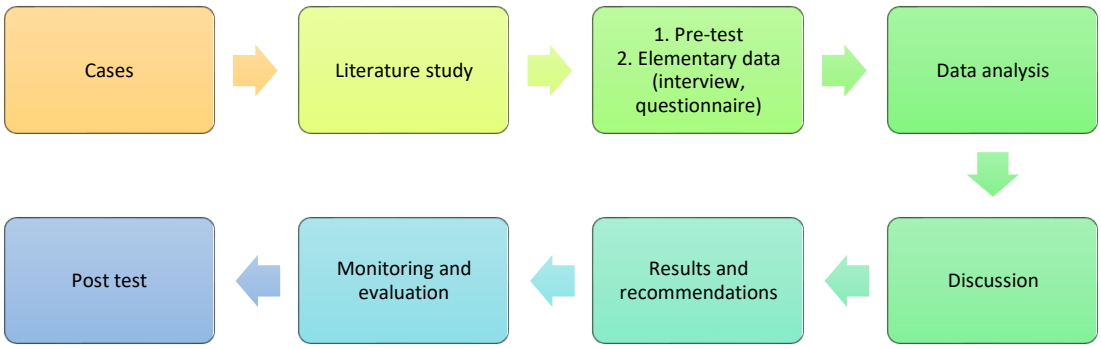

Figure1 Study of flow procedure implementation

RESULTS AND DISCUSSION

The flood DRR education program was implemented at TKIU Birrul Walidain Muhammadiyah Plupuh, Sragen Regency, from January to March 2025, involving 25 preschool children aged approximately 4–6 years. The implementation represented the action phase of the PAR cycle, in which learning activities were carried out collaboratively with teachers and supported by structured observation and visual documentation.

One of the core activities was a safe evacuation simulation. Based on observation records documented in the program progress report, all 25 children actively participated in the simulation by following designated evacuation routes and assembling at predetermined safe points within the school area. Figure 2 visually documents this activity, showcasing children participating in guided evacuation drills under teacher supervision. Observational data indicate that children were able to follow evacuation instructions sequentially, demonstrating basic procedural understanding of flood response behavior (Khasanah et al., 2018).

Figure 2 Simulation of safe evacuation of early childhood

In addition to simulations, educational games were used to reinforce flood preparedness concepts. Observation notes indicate that all participating children were actively involved in game-based learning activities designed to strengthen recognition of disaster signs and appropriate safety actions (Hsb et al., 2022; Rahiem & Rahim, 2020). Figure 3 presents examples of the educational tools used during these sessions, including (a) a natural disaster puzzle and (b) disaster preparedness quartet cards. These visual materials support observational findings that children were able to recall disaster-related information during interactive play.

(a) (b)

Figure 3 Examples of educational games (a) Natural disaster puzzle (b) disaster preparedness quartet cards

Creative storytelling activities were also implemented to address emotional and cognitive aspects of flood preparedness. Figure 4 illustrates an interactive storytelling session focusing on flood scenarios, during which facilitators monitored children's responses and engagement. Observation data indicate that children demonstrated increased verbal participation and reduced visible anxiety when discussing floods after storytelling sessions.

Figure 4 An interactive story about floods for young children and a program to keep an eye on them

To assess learning outcomes resulting from the PAR-based intervention, a pre-test and post-test assessment was conducted before and after program implementation. The assessment measured four indicators: children's understanding of disaster types, response to disaster situations, self-rescue ability, and fear regulation. Table 1 presents a comparison

of average pre-test and post-test scores for the 25 participating children, providing quantitative evidence of changes in flood disaster preparedness.

Table 1 Comparing pre-test and post-test results on children's character comprehension

No	Assessment items	Average pre-test value	Average post-test value
1.	Children can understand the types of disasters	21%	79%
2.	Children can respond to the situations they face	26%	83%
3.	Children can understand self-rescue when a disaster occurs	23%	77%
4.	Children are able to regulate the fears they face	25%	81%
	Total Average	23.8%	80%

As shown in Table 1, children's understanding of disaster types increased from 21% (pre-test) to 79% (post-test). The ability to respond to disaster situations showed a substantial improvement, rising from 26% to 83%. Similarly, children's understanding of self-rescue actions increased from 23% to 77%, while fear regulation improved from 25% to 81%. Overall, the total average score increased from 23.8% before the intervention to 80% after the intervention.

From a PAR perspective, the observed improvements reflect the effectiveness of iterative, participatory, and context-sensitive learning processes. The quantitative outcomes presented in Table 1 are supported by observational and visual data which document children's active participation during evacuation simulations, educational games, and storytelling activities.

The integration of action, observation, and reflection enabled continuous adjustment of learning activities based on children's responses and engagement levels. Teachers' involvement as co-implementers strengthened learning reinforcement during and after program activities. The combination of measurable score improvements and documented behavioral participation indicates that the PAR-based flood DRR education program produced empirically verifiable outcomes, rather than normative or perception-based claims.

This case study at TKIU Birrul Walidain offers significant insights into the execution of interactive disaster risk reduction education for preschoolers in a flood-prone Indonesian setting. The program's use of simulation, educational games, and storytelling is in line with well-known ideas about early childhood education, which say that kids learn best when they are actively involved and having fun (Pyle & Danniels, 2017; De Angelis et al., 2019). The children's positive engagement and basic understanding support the increasing evidence that preschoolers can learn and participate in DRR activities when presented in developmentally appropriate manners. The activities were interactive, especially the evacuation simulation, which gave people real-life experiences that probably helped them understand better than if they had just been told what to do. This practical application corroborates the findings of (Sitepu et al., 2024), which demonstrated the efficacy of animated drill videos, and (Aboud et al., 2016), whose research in Sumba indicated enhancements in disaster risk reduction knowledge subsequent to a preschool program.

The successful implementation, as reported, shows that it is possible to add DRR education to existing preschool programs in Indonesia. The partnership between the university team and the local kindergarten (TKIU Birrul Walidain) is a good example of how to do community service and share knowledge. The reported participation of teachers and parents, albeit not elaborated upon in detail, is essential, as continuous reinforcement of safety messages in both educational and domestic settings is vital for enduring behavioral modification (Khairunnisa et al., 2024; Salam et al., 2025; Utama et al., 2024).

However, this community service program suffers from limitations in that it was short and did not allow for more accurate measurement of changes in knowledge or behavior. Implementers reported observational data, which may be biased, to assess the program's effectiveness. The intervention and follow-up period was only three months, so it was impossible to assess how well people remembered what they learned or how it changed their behavior during the disaster. The source documents also do not provide much information about the games and stories themselves, such as how many parents conducted the activities at home with their children. This community service program provides preliminary evidence that interactive DRR education is beneficial in Indonesian preschools (Chandrasari et al., 2025; Imam et al., 2025; Nurisusilawati & Rachmawaty, 2023). The study emphasizes the importance of adapting teaching methods based on the child's age and suggests that such programs can help preschoolers learn and better understand disasters. In the future, using a variety of community service methods will help us obtain stronger evidence on the long-term effectiveness of disaster mitigation programs in preschool children. This evidence will not only help us understand how these programs influence children's awareness of disasters but will also help policymakers and teachers find better ways to teach early childhood education. Ultimately, the goal is to create a generation of children who are safer and more informed and better prepared for future emergencies.

CONCLUSION

TKIU Birrul Walidain Muhammadiyah Plupuh in Sragen, near the flood-prone Bengawan Solo River, launched an interactive program for preschoolers on disaster risk reduction and flood preparedness. This case study detailed program implementation. The program engaged young learners and taught them about disaster risks and prevention using age-appropriate methods like evacuation simulations, educational games, and creative storytelling. Based on implementers' observational data, interactive, play-based methods are practical and effective for incorporating principles of disaster risk reduction into early childhood education in Indonesia. Kids enjoy learning and have more safety control with this strategy. The program's purpose is to teach young people these vital ideas so they can better handle and reduce disasters in their communities. This program helps show that young children can build disaster resilience. These engaging programs teach basic skills and knowledge to promote safety and reduce vulnerability. The university-local school partnership is an example of community participation.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

DSK, ASR, PA, and NFM collaboratively formulated the ideas presented and oversaw the findings of this work. AA developed the theory. DSK, ASR, PA, NFM, and AA were involved in the implementation of the community service program. DSK and AA verified the results of the field analysis and encouraged their publication. DSK, ASR, PA, NFM, and AA discussed the results and contributed to the final manuscript.

AI DISCLOSURE STATEMENT

This article was similarity checked using a subscription-based TURNITIN and used a subscription-based QUILLBOT to check grammar and writing quality. After using these applications, the authors revised the notes provided to improve the quality of the article.

The authors declare that this research was compiled, researched, written, and edited without the aid of artificial intelligence (AI) techniques.

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