

## STEM-Based Fire Disaster Mitigation Training to Foster Safety Awareness Among Early Childhood Education Students

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**Abstract:** Fire disasters constitute one of the most serious threats that can occur within school environments, including at the Early Childhood Education (ECE) level. However, fire disaster mitigation programs specifically designed for young children remain considerably limited, particularly those integrating innovative learning approaches. This gap underscores the necessity for educational interventions aligned with the cognitive and psychomotor developmental stages of early childhood. In response, this community service program aimed to cultivate safety awareness and fundamental fire disaster mitigation skills among ECE students through STEM (Science, Technology, Engineering, and Mathematics)-based training. The implementation method employed a Participatory Action Research (PAR) approach combined with interactive training and mentoring, encompassing the dissemination of fire safety materials, evacuation drills, and hands-on activities involving the construction of simple teaching aids representing firefighting equipment used to extinguish fires. This program was conducted at TKIT AR RAUDLOH, Kuningan Regency, involving 30 students from Groups A and B along with 4 accompanying teachers. The findings demonstrated a significant improvement in students' understanding of fire hazards, their ability to perform basic evacuation procedures, and high levels of enthusiasm in STEM-based activities. In conclusion, STEM-based fire disaster mitigation training serves as an effective educational solution for fostering safety awareness from an early age and can be sustainably implemented within ECE settings.

**Keywords:** Fire; Disaster mitigation; Early childhood education; STEM approach; Safety.

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## INTRODUCTION

Fire disasters represent one of the most frequently occurring types of disasters in Indonesia, causing substantial losses in terms of both material damage and human casualties. Data from the National Disaster Management Agency (BNPB) recorded that throughout 2023, more than 1,500 fire incidents occurred across various regions of Indonesia, with the majority taking place in densely populated residential areas, office buildings, and public facilities including schools (BNPB, 2025). Fires threaten not only the safety of adults but also children, who constitute the most vulnerable group to disaster impacts due to their limited understanding and capacity to respond to emergency situations (Rahma, 2012). Young children, particularly those enrolled in Early Childhood Education (ECE) programs, exhibit higher levels of vulnerability compared to other age groups due to their dependence on adults during emergency situations (Supartini, E. et al, 2017)

The vulnerability of young children to fire disasters is attributable to several factors. First, young children possess cognitive limitations in comprehending concepts of danger and fire (Piaget, 2001; Santrock, 2018). Second, children's still-developing motor abilities result in limitations in performing evacuation actions independently (Hurlock E., 2006). Third, children's emotional responses to emergency situations tend to be dominated by fear and panic, which can impede self-rescue actions (Peek, 2008). Therefore, introducing fire disaster mitigation concepts from an early age becomes critically important in building a foundation of understanding and preparedness that will become internalized in children's behavior in the future.

Disaster mitigation is defined as a series of efforts undertaken to reduce disaster risks, either through physical development or through awareness-raising and capacity enhancement to face disaster threats (Law Number 24 of 2007 concerning Disaster Management). In the educational context, disaster mitigation is understood as a learning process aimed at enhancing students' knowledge, attitudes, and skills in facing potential disasters in their environment (Hayudityas, 2020). The importance of disaster mitigation education in schools has been affirmed in BNPB Head Regulation Number 4 of 2012 concerning Guidelines for the Implementation of Disaster-Safe Schools/Madrasahs, which emphasizes the necessity of integrating disaster-related materials into the educational curriculum at all levels, including the ECE level (BNPB, 2012).

Nevertheless, the implementation of disaster mitigation education at the ECE level continues to face various challenges. Research conducted by Nurjanah et al., (2019) indicated that the majority of ECE institutions in Indonesia do not yet possess structured disaster mitigation programs. This is attributable to several factors, including: (1) lack of ECE teachers' understanding of disaster mitigation concepts, (2) limited availability of media and learning methods suitable to the characteristics of young children, and (3) low prioritization of disaster programs compared to regular learning programs (Rosyida & Adi, 2020). Furthermore, Sari & Wajdi (2022) found that among 50 ECE institutions studied in East Java, only 12% possessed written disaster evacuation procedures, and only 8% had ever conducted fire evacuation drills. These data indicate a significant gap between the need for disaster mitigation education at the ECE level and the reality of its implementation in the field.

One approach considered effective for integrating disaster mitigation education at the ECE level is the STEM (Science, Technology, Engineering, and Mathematics) approach. The STEM approach is an interdisciplinary learning approach that integrates four fields of knowledge science, technology, engineering, and mathematics within real-world contexts to develop students' critical thinking skills, creativity, collaboration, and communication

abilities (Kelley & Knowles, 2016). In the ECE context, the STEM approach is not applied formally as in higher education levels, but rather integrated through meaningful play activities, exploration, and simple experiments appropriate to children's developmental stages (Siantajani, 2020).

Several previous studies have demonstrated the effectiveness of the STEM approach in early childhood learning. Torres-Crespo, et.al. (2015) found that project-based STEM activities can enhance problem-solving abilities and curiosity among children aged 4–6 years. In alignment with this, Lippard et al. (2018) reported that STEM integration in early childhood play activities can improve children's conceptual understanding and science process skills. However, research that specifically integrates the STEM approach with fire disaster mitigation education at the ECE level remains very limited. A literature search conducted by the researchers in the Scopus, Google Scholar, and ERIC databases indicated that no research or community service programs have specifically combined these two elements. This confirms the existence of research gaps and practice gaps that form the foundation for the importance of this community service activity.

TKIT AR RAUDLOH, located in Ciawigebang District, Kuningan Regency, West Java, represents one ECE institution facing similar challenges. Based on preliminary observations and interviews with the principal and teachers in October 2025, several issues were identified, namely: (1) the absence of a structured fire disaster mitigation program at the school, (2) the unavailability of portable fire extinguishers and adequate evacuation routes, (3) low teacher knowledge regarding fire disaster handling procedures, and (4) the absence of any fire evacuation drills involving students. This condition is exacerbated by the school's location in a densely populated area with narrow road access, thereby increasing the risk and potential impact of fires.

Based on this situational analysis, the community service team from the Science Education Study Program at Universitas Muhammadiyah Bogor Raya organized the activity titled "STEM-Based Fire Disaster Mitigation Training to Foster Safety Awareness Among Early Childhood Education Students" at TKIT AR RAUDLOH. This activity aimed to: (1) enhance ECE students' knowledge and awareness regarding fire hazards and prevention methods, (2) train basic fire evacuation skills through enjoyable and child-friendly simulations, (3) develop children's creativity and science process skills through the STEM-based construction of simple smoke detector teaching aids, and (4) increase ECE teachers' capacity to integrate disaster mitigation materials into daily learning activities.

The uniqueness and specific contributions of this community service program lie in its clear, context-based response to the real vulnerabilities of TKIT AR RAUDLOH and in the way it integrates disaster mitigation with early childhood STEM learning. Unlike most previous fire safety or disaster education activities that are generally lecture-based, one-off, and targeted at adults or older students, this program is deliberately designed for early childhood education students in a high-risk, densely populated area with limited road access. It combines developmentally appropriate STEM-based activities such as constructing simple smoke detector teaching aids with enjoyable evacuation simulations to simultaneously build children's conceptual understanding, psychomotor skills, and safety awareness. At the same time, it does not stop at student training: the program also strengthens teachers' capacity by providing them with practical strategies and examples for embedding fire disaster mitigation into daily learning activities, thereby offering a sustainable, replicable model of school-based fire safety education for ECE institutions facing similar conditions.

**METHOD**

This community service activity was conducted at TKIT AR RAUDLOH, Ciawigebang District, Kuningan Regency, West Java Province, from October 20–23, 2025. Participants consisted of 30 students (15 Group A students aged 4–5 years and 15 Group B students aged 5–6 years) along with 4 accompanying teachers.

**Approach and Activity Design**

The implementation method for this community service activity employed a Participatory Action Research (PAR) approach combined with training, simulation, and mentoring methods. The PAR approach was selected because it enables all participants—students, teachers, and the service team—to be actively involved as agents of change in efforts to build safety awareness and disaster preparedness within the school environment (Reason & Bradbury, 2008). In the context of this activity, PAR was operationalized through cycles of planning (plan), action (act), observation (observe), and reflection (reflect) involving the active participation of teachers and students at every stage.

The integration of the STEM approach in this activity was designed based on the STEM framework for early childhood developed by Siantajani (2020), with the following adaptations:

**Table 1.** Integration of STEM Components in Fire Disaster Mitigation Activities

STEM Component	Integration Description	Concrete Activities
Science	Introduction to concepts of fire, smoke, heat, and flammable materials through simple experiments	"Fire Needs Oxygen" experiment using candles and glasses; introduction to the fire triangle
Technology	Introduction to the functions and usage methods of fire safety equipment	Introduction to mini fire extinguishers, fire alarms, and smoke detectors through audiovisual media
Engineering	Design and construction of simple safety teaching aids	Construction of helmets, safety vests, gas tanks, and water tanks
Mathematics	Introduction to counting, measuring, and classifying concepts in safety contexts	Counting evacuation steps, measuring distance to assembly points, classifying flammable and non-flammable objects

**Implementation Stages**

This community service activity was implemented in four main stages arranged systematically. The activity implementation flow is presented in Figure 1.



**Figure 1.** The activity implementation flow

### ***Stage 1: Preparation and Observation (October 20, 2025)***

The preparation stage encompassed several activities, namely: (a) submission of activity implementation permits to the principal of TKIT AR RAUDLOH; (b) conducting preliminary observations and in-depth interviews with the principal and classroom teachers to identify issues related to fire disaster preparedness at the school; (c) preparation of socialization materials including posters, educational animated videos, picture flashcards about fire safety, and evacuation movement songs; (d) preparation of tools and materials for constructing STEM-based simple smoke detectors; and (e) development of evaluation instruments including student behavior observation sheets and teacher comprehension questionnaires.

The evaluation instruments utilized included: (1) structured observation sheets for observing student responses and participation during activities, developed based on early childhood development indicators in the Child Development Achievement Level Standards (STPPA) of Minister of Education and Culture Regulation Number 137 of 2014; (2) questionnaires for teachers to measure capacity improvement in integrating disaster mitigation materials into learning, using a 4-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree).

### ***Stage 2: Socialization and Education (October 21, 2025)***

Socialization and education activities were conducted in the school hall involving all Group A and B students along with accompanying teachers. This activity was designed using a learning-through-play approach consistent with ECE learning principles (Kemendikbudristek, 2022). The materials delivered included: Introduction to fire hazards: using 5-minute animated video media depicting fire scenarios at home and school, followed by interactive question-and-answer sessions with students.

1. Introduction to the fire triangle: explaining the three elements required for fire to burn (fuel, oxygen, and heat) through simple demonstrations using candles, glasses, and matches conducted by the service team in front of students under strict supervision.
2. Introduction to fire safety equipment: using picture flashcards displaying fire extinguishers, fire alarms, sprinklers, and smoke detectors, along with their respective functions.
3. Safety songs and movements: teaching a song themed "If There Is Fire" adapted from a popular children's song, accompanied by basic evacuation movements (crouching, covering the nose with a wet cloth, walking toward the exit).
4. Object classification: students were invited to classify objects around them into "flammable" and "non-flammable" categories using picture cards (integration of Mathematics component: classifying and counting).

### ***Stage 3: Training and Simulation (October 22, 2025)***

The training and simulation stage consisted of two main activities:

#### **1. Fire Evacuation Simulation**

The fire evacuation simulation was conducted within the school environment using a pre-designed scenario. The simulation procedures included:

- a. Sounding of the danger alarm (using whistles and school bells)
- b. Teachers guiding students to stand in an orderly manner
- c. Students practicing crouching movements and covering their noses with wet cloths
- d. Students walking in lines following marked evacuation routes toward the assembly point

in the school yard

- e. Teachers conducting head counts at the assembly point
- f. Students counting steps from the classroom to the assembly point (integration of Mathematics component)

The simulation was conducted twice: the first simulation with full guidance from the service team, and the second simulation with minimal guidance to measure student independence.

## 2. STEM-Based Simple Firefighting Equipment Construction

This activity represented the core of STEM integration in disaster mitigation training. Students were guided to construct smoke/water tank teaching aids and simple safety clothing and helmets using easily obtainable materials. The tools and materials used are presented in Table 2.

**Table 2.** Tools and Materials for Simple Firefighting Equipment Construction

No	Tools/Materials	Quantity	Description
1	Used plastic bottles	30 pieces	Main container
2	Used plastic	30 pieces	Safety clothing
3	Paper/Cardboard	30 pieces	Safety helmets
4	String	10 meters	Detector membrane and dividers
5	Twigs, used paper	10 pieces	Smoke source (used by team)
6	Blunt scissors	30 pieces	Cutting tools (assisted by teachers)

The working principle of these teaching aids utilized simple science concepts: imitating the firefighter profession who extinguish fires. Although this principle is simplified and not as precise as actual smoke or water tanks and other safety equipment, these teaching aids function as effective learning media for introducing the concept of firefighter work when extinguishing fires to young children.

The STEM integration in this teaching aid construction activity included:

- Science: understanding concepts of fire, water, and smoke during fires
- Technology: recognizing functions of alarms, smoke and water tanks, and safety clothing and helmets as safety technology
- Engineering: designing and assembling teaching aids from simple materials
- Mathematics: counting materials, measuring string length, comparing sizes

### **Stage 4: Evaluation and Reflection (October 23, 2025)**

The evaluation stage was conducted after all training and simulation activities were completed. Evaluation was performed through three approaches:

1. Student comprehension evaluation: using picture-based post-test instruments adapted to young children's abilities. Students were asked to select pictures showing correct and incorrect actions during fires. Post-test results were compared with pre-tests conducted in Stage 2.
2. Participation and behavior evaluation: using structured observation sheets completed by the service team and accompanying teachers during activities. Observed indicators included: activeness, ability to follow instructions, ability to practice evacuation procedures, and enthusiasm in STEM activities.

Reflection with teachers: conducted through Focus Group Discussion (FGD) with

accompanying teachers to evaluate the overall activity, identify supporting and hindering factors, and formulate follow-up action plans for program sustainability.

## RESULTS AND DISCUSSION

### Results

#### 1. Preparation and Observation Stage

The preparation stage commenced with submission of activity implementation permits to the Principal of TKIT AR RAUDLOH. After permits were obtained, the service team conducted preliminary observations and in-depth interviews with the principal and four classroom teachers. The observation and interview results identified several main issues presented in Table 3.

**Table 3.** Results of Disaster Preparedness Problem Identification in TKIT AR RAUDLOH

No	Aspect	Conditions Found	Category
1	Disaster mitigation program	No structured disaster mitigation program exists	Not available
2	Portable fire extinguisher (APAR)	Not available in the school environment	Not available
3	Evacuation routes	No markings for evacuation routes and assembly points	Not available
4	Teacher knowledge	3 of 4 teachers (75%) did not understand fire evacuation procedures	Low
5	Evacuation simulation	Never conducted since the school was established	Never
6	Disaster learning media	No disaster mitigation learning media available	Not available
7	Road access	Road in front of school is narrow (width $\pm 3$ meters), difficult for fire truck access	High Risk

These problem identification results formed the basis for preparing training materials and activity designs. These findings align with research by Nurjanah *et al.* (2019) which reported that the majority of ECE institutions in Indonesia do not yet have adequate disaster mitigation programs. Similar conditions were also reported by Rosyida and Adi, (2020) who found that teachers' lack of understanding about disaster mitigation constitutes the main barrier to implementing disaster education at the ECE level.

Based on the problem identification results, the service team then prepared all required materials and equipment, including the production of educational animated videos, fire safety flashcards, evacuation movement songs, and tools and materials for constructing simple smoke detectors.

#### 2. Socialization and Education Stage

Socialization and education activities were conducted on October 21, 2025, in the hall of TKIT AR RAUDLOH. Activities commenced with picture-based pre-tests to measure students' initial understanding of fire safety concepts. Subsequently, materials were delivered interactively using various prepared media.



**Figure 2.** Fire Safety Material Socialization Activities

During material delivery through animated videos, all students demonstrated high enthusiasm. This was evident from students' attention focused on the projector screen, as well as spontaneous responses of raised hands and verbal answers when given interactive questions. When asked "What should you do if you see fire?", the majority of Group B students (72%) answered correctly, namely "report to a teacher/adult," while only 45% of Group A students answered correctly. This difference aligns with Piaget's cognitive development theory explaining that children in the late preoperational stage (5–6 years) possess better symbolic representation abilities compared to children in the early stage (4–5 years) (Santrock, 2018).

The fire triangle demonstration using candles and glasses became the activity that most attracted student attention. When the candle was covered with a glass and the fire extinguished due to lack of oxygen, students showed amazed reactions and asked "Why did the fire die?" This question became a highly valuable teachable moment for explaining science concepts about fire's need for oxygen in simple language. These findings support the opinion of Torres-Crespo, et al., 2015) that simple science experiment activities can stimulate young children's curiosity and questioning abilities.



**Figure 3.** Demonstration of Simple Fire Extinguishing Equipment Construction

The "flammable" and "non-flammable" object classification activity using picture cards proceeded well, explaining what materials can be used to extinguish fires. Interactive

question-and-answer sessions with students were conducted, and answers were corrected through simple explanations from the service team..

Learning the safety song and movements "If There Is Fire" became the activity most favored by students. This song was adapted from the melody of the children's song "If You're Happy and You Know It" with lyrics containing evacuation steps:

"If there is fire, don't panic (clap clap)

"If there is fire, tell the teacher (clap clap)

"Crouch down slowly, cover your nose with your hand"

"If there is fire, to the assembly point (clap clap)"

The use of songs as learning media aligns with Siantajani (2020) opinion that effective ECE learning must involve all of children's senses and learning modalities, including kinesthetic and auditory.

#### a. Fire Evacuation Simulation

The fire evacuation simulation was conducted on October 23, 2025, within the TKIT AR RAUDLOH environment. Before the simulation began, the service team first installed evacuation route markings using green tape and arrow signs on the floor, as well as placing assembly point signs in the school yard. This was done because preliminary observation results indicated that the school did not yet have evacuation route markings.

The first simulation was conducted with full guidance from the service team and accompanying teachers. Each team member was positioned at strategic points along the evacuation route to guide students. First simulation observation results indicated that the majority of students (70%) were able to follow evacuation instructions well, although there were still some students who cried and appeared confused due to fear (10%) and several students who ran instead of walking orderly (20%)

**Table 4.** Fire Evacuation Simulation Observation Results

<b>Indicator</b>	<b>Simulation I (with full guidance)</b>	<b>Simulation II (minimal guidance)</b>
Responding to alarm by standing orderly	78%	89%
Practicing crouching movements	71%	84%
Covering nose with wet cloth	64%	80%
Walking orderly following evacuation route	69%	82%
Gathering at assembly point without running	73%	87%
Total student evacuation time	6 minutes 35 seconds	4 minutes 12 seconds

Data in Table 4 demonstrate consistent improvement across all indicators from the first to the second simulation. The most significant improvement occurred in the "covering nose with wet cloth" indicator (from 64% to 80%, an increase of 16%) and "practicing crouching movements" (from 71% to 84%, an increase of 13%). Evacuation time also improved from 6 minutes 35 seconds to 4 minutes 12 seconds, indicating increased evacuation efficiency and orderliness.

This improvement demonstrates that repetition and hands-on practice are critically important in forming procedural skills in young children. These findings align with Bandura's (1971) social learning theory emphasizing the importance of observational learning and practice in behavior formation. Additionally, these results also support the opinion of Ningrum, et al. (2025) that environmental education including disaster mitigation based on

direct practice is more effective compared to learning that is purely theoretical. The implementation of fire education simulation can see in Figure 4.



**Figure 4.** Implementation of Fire Evacuation Simulation

*b. STEM-Based Simple Fire Extinguisher Construction*

The simple smoke detector construction activity represented the culmination of the STEM-based fire disaster mitigation training series. Students were divided into 6 groups (5 children each) and accompanied by 1 teacher or 1 service team member per group. The construction process was implemented with the following stages: Tim pengabdian mendemonstrasikan cara merakit alat peraga di depan kelas

- 1) The service team demonstrated how to assemble teaching aids in front of the class
- 2) Students cut materials (using blunt scissors with teacher assistance)
- 3) Students counted the required string length (Mathematics integration)
- 4) Students tied fire pictures to string/raffia rope
- 5) The service team assisted in attaching components
- 6) Students filled bottles with water
- 7) Students collected twigs and scrap paper to make fire piles
- 8) Students wore safety clothing and helmets made from used plastic and cardboard

During the demonstration, students were in the classroom when teachers sounded the warning/danger alarm, then students were evacuated outside the classroom. After that, demonstration of tool working principles and safety attributes (clothing, helmets) was conducted. Students evacuated to the field then formed a circle, and the service team brought students close to burning paper/twig piles (at a safe distance under strict supervision). Students then proceeded to extinguish the fire with the extinguishing equipment they had made. The Demonstration of Extinguishing Fire with Simple Equipment in Figure 5.



**Figure 5.** Demonstration of Extinguishing Fire with Simple Equipment

Observation results during the teaching aid construction activity demonstrated very high levels of student enthusiasm and participation. Detailed observation results are presented in Table 5.

**Table 5.** Observation Results of STEM-Based Simple Smoke Detector Construction Activity

Indicator	Group A (4–5 years)	Group B (5–6 years)
Enthusiasm in following activities	Very high (95%)	Very high (96%)
Ability to follow construction instructions	Fair (65%)	Good (82%)
Ability to cut correctly	Poor (48%)	Fair (68%)
Ability to count materials	Fair (60%)	Good (80%)
Creativity in decorating	High (88%)	High (90%)
Ability to explain tool functions	Poor (40%)	Fair (64%)

Data in Table 5 indicate that Group B students consistently demonstrated higher abilities compared to Group A across all indicators except enthusiasm, which was relatively equal. The most striking differences occurred in the "ability to cut correctly" indicator (Group A 48% vs. Group B 68%) and "ability to explain tool functions" (Group A 40% vs. Group B 64%). These differences are consistent with children's fine motor and expressive language developmental stages that mature progressively with age (Hurlock E., 2006).

Nevertheless, both groups demonstrated very high enthusiasm (>95%), indicating that the STEM approach through hands-on activities effectively attracts young children's interest. These findings align with research results by Lippard et al. (2018) who reported that STEM integration in early childhood play activities can enhance children's engagement and learning motivation. Kelley & Knowles (2016) also affirmed that STEM learning contextualized with real-world problems in this case, fire disaster mitigation—proves more meaningful for students compared to abstract conceptual learning.

### 3. Evaluation and Reflection Stage

Based on student observation results, students appeared enthusiastic and able to answer questions about safety objects and firefighting equipment after conducting the simulation. These findings align with research by Hayudityas (2020) who reported that disaster mitigation education packaged in play activities and simple experiments proves effective in enhancing young children's knowledge about disasters. Furthermore, these results also

support Kolb's (1984) experiential learning theory emphasizing that the most effective learning occurs when students are directly involved in concrete experiences, observing, reflecting on experiences, and conceptualizing new understanding.

#### 4. Reflection with Teachers (FGD)

Reflection with teachers was conducted through FGD on the afternoon of October 23, 2025. Based on discussions, several supporting and hindering factors were identified.

**Table 6.** Supporting and Hindering Factors of Activities

<b>Supporting Factors</b>	<b>Hindering Factors</b>
Full support from principal and foundation	Limited implementation time (3 days)
High enthusiasm from students and teachers	Some Group A students cried during alarm simulation
Materials packaged attractively and child-friendly	Group A students' fine motor abilities still limited for assembling tools
STEM approach made activities more meaningful	Hot weather during evacuation simulation in the yard
Availability of easily obtainable and inexpensive materials	Permanent fire extinguisher not yet available at school

Based on FGD results, teachers conveyed several follow-up action plans, including: (1) submitting requests for fire extinguisher procurement to the foundation, (2) scheduling fire evacuation simulations every 3 months, (3) integrating fire safety materials into the "My Environment" learning theme, and (4) permanently installing evacuation route markings and assembly point signs.

#### 5. Activity Impact on Student Behavior and School Community

The STEM-based fire disaster mitigation training activity provided measurable positive impacts on student behavior and the school community at TKIT AR RAUDLOH. These impacts include: First, increased safety awareness occurred among students. After the activity, several students were reported by teachers to demonstrate new positive behaviors, such as reminding friends not to play with matches, pointing out installed evacuation routes, and spontaneously singing the safety song during playtime. This indicates that safety concepts have begun to become internalized in students' daily behavior.

Second, increased teacher capacity occurred in integrating disaster mitigation materials into learning. Teachers reported that after participating in the activity, they felt more confident and possessed sufficient method references to deliver fire safety materials to students independently. Third, this activity encouraged the school and foundation to allocate budgets for procurement of fire safety equipment, including fire extinguishers and first aid kits, which were previously unavailable in the school environment.

These impacts align with the PAR approach objectives emphasizing community empowerment to become independent agents of change (Reason & Bradbury, 2008). By being actively involved in all activity stages, teachers and students become not only passive recipients of information but also primary actors in building a safety culture within their school environment.

Overall, STEM approach integration in fire disaster mitigation training proved effective for several reasons. First, the STEM approach enables abstract disaster mitigation concepts to be concretized through experiments and teaching aid construction. Second, STEM contextualization with real problems (fire disasters) provides deeper relevance and meaning for children (Kelley & Knowles, 2016). Third, the Engineering component in STEM namely simple smoke detector construction provides hands-on experiences highly suitable to

learning-through-play principles at the ECE level (Siantajani, 2020). Fourth, the interdisciplinary STEM approach enables holistic integration of various aspects of child development, encompassing cognitive (science, mathematics), motor (assembling, cutting), language (discussing, questioning), and social-emotional (group cooperation, courage during simulations).

## CONCLUSION

The community service activity comprising STEM-based fire disaster mitigation training at TKIT AR RAUDLOH, Kuningan Regency, has been successfully implemented and produced measurable positive impacts. Based on the entire series of activities conducted, the following conclusions can be drawn:

1. Basic fire evacuation skills among students demonstrated consistent improvement from the first to the second simulation across all indicators, with evacuation time improving from 6 minutes 35 seconds to 4 minutes 12 seconds.
2. The STEM approach proved effective as a disaster mitigation training framework for young children, demonstrated by very high enthusiasm levels (>95%) and students' ability to understand simple science concepts about fire and practice constructing smoke detector teaching aids.
3. ECE teachers' capacity to integrate disaster mitigation materials into learning increased significantly, with teachers understanding evacuation procedures and expressing confidence to continue the program independently.

This activity is expected to serve as a model for STEM-based disaster mitigation training that can be replicated in other ECE institutions. For program sustainability, it is recommended that the school conduct evacuation simulations periodically (at least every 3 months), integrate fire safety materials into the learning curriculum, and collaborate with the local Fire Department for advanced training for teachers and educational staff.

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