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Understanding the Use of Evacuation Routes as Earthquake and Tsunami Disaster Mitigation Education in Junior High Schools in Puring District

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ABSTRACT

This study aims to determine the level of understanding among public junior high school students in Puring District regarding the use of earthquake and tsunami evacuation routes, analyze the implementation of disaster mitigation education, and examine the influence of mitigation education on evacuation route comprehension. The study employs a quantitative approach. Data were collected through questionnaires distributed to public junior high school students in Puring District and analyzed using descriptive statistics and regression analysis. The results indicate that both the students' level of understanding regarding evacuation routes and the implementation of disaster mitigation education fall into the high category. Regression analysis reveals a significant positive influence of disaster mitigation education on understanding evacuation route usage, demonstrating that better educational implementation directly enhances student comprehension. Theoretically, these findings reinforce the framework of school-based risk reduction by highlighting educational intervention as a key driver of disaster readiness. Practically, this study emphasizes the need to strengthen disaster mitigation education by integrating disaster-related material into the curriculum, conducting periodic evacuation drills, and optimizing disaster management within schools. Furthermore, the study's findings serve as a basis for policymakers to develop comprehensive disaster mitigation education programs that align with the specific hazard characteristics of Puring District.

1. Introduction

Natural disasters are a series of events that threaten and disrupt community life, caused by natural, non-natural, or human factors, resulting in loss of life, environmental damage, property loss, and psychological impacts (BNBP, 2007). Geographically, Indonesia is situated within the Pacific Ring of Fire and surrounded by active tectonic plates, leading to a high level of seismic activity. These conditions make Indonesia highly prone to earthquakes and tsunamis, as evidenced by major events such as the 2004 Aceh tsunami, the 2006 Yogyakarta earthquake, and the 2018 Palu earthquake and tsunami (Gaffara et al., 2023). Tsunamis remain a major hazard for coastal populations, particularly in tectonically active zones such as Indonesia (Tarihoran et al., 2025). This high disaster risk necessitates systematic and sustainable

mitigation efforts, one of which is disaster education in schools, a means to build students' knowledge, attitudes, and skills for handling emergency situations.

Puring District in Kebumen Regency is located along the southern coast of Java, an area highly vulnerable to earthquakes and tsunamis caused by subduction activity between the Indo-Australian and Eurasian plates. Assessments by the Meteorology, Climatology, and Geophysics Agency (BMKG) classify this southern coastal region as a tsunami "red zone," necessitating the strengthening of early warning systems, the provision of evacuation routes, and the enhancement of community capacity through disaster mitigation education. In this context, schools play a strategic role in instilling a culture of disaster awareness in students from an early age (KEMENKOPKM, 2022). This approach aligns with Law Number 24 of 2007 concerning Disaster Management and the 2020 policy of the National Agency for Disaster Countermeasure (BNPB), both of which emphasize the importance of integrating disaster education into formal schooling to foster a disaster-resilient society.

Junior high school students are at a stage of physical, cognitive, and emotional development that renders them vulnerable in disaster situations. Therefore, structured disaster mitigation education is essential to ensure students understand potential hazards, self-rescue procedures, and the proper use of evacuation routes (Puspitasari et al., 2021; UNESCO, 2012). Theoretically, school-based mitigation initiatives, such as the Disaster-Safe Education Unit (*Satuan Pendidikan Aman Bencana* / SPAB), are expected to establish ideal safety standards through continuous simulation drills, integrated learning materials, and clear spatial signage (BNPB, 2007; Komara et al., 2026). However, preliminary observations at public junior high schools in Puring District revealed that some students still lack a proper understanding of evacuation procedures. This situation is likely attributable to suboptimal dissemination of disaster-related information, infrequent evacuation drills, and a lack of supporting resources, such as evacuation route maps, within the school environment (Annisah et al., 2025; Tambunan et al., 2026). While previous studies have predominantly focused on technical spatial route modeling (Maharani et al., 2026; Tarihoran et al., 2025) or broader community resilience (Limehuwey et al., 2026; Soviana et al., 2025), these findings indicate a significant gap between the theoretical expectations of disaster mitigation education and the students' actual understanding of evacuation route usage in high-risk coastal zones.

Various previous studies have examined earthquake and tsunami disaster mitigation from diverse perspectives. Puspitasari et al (2021) and Tambunan et al. (2026) emphasized the critical role of mitigation education in building disaster readiness within coastal communities and school environments. On technical and spatial dimensions, Maharani et al (2026) modeled tsunami inundation scenarios, while Tarihoran et al. (2025) evaluated evacuation routes and shelter capacities using GIS-based travel time analysis. Furthermore, Soviana et al (2025) developed evacuation routes tailored for coastal tourism zones to enhance disaster resilience, and recent studies by Annisah et al. (2025), Limehuwey et al. (2026), and Rumtutuly et al. (2026) demonstrated the efficacy of school-based simulations and interactive media in improving student preparedness. While these studies have contributed significantly to disaster mitigation frameworks, most have focused primarily on physical infrastructure, spatial route mapping, or general community participation. Consequently, there remains a critical research gap regarding how structured disaster mitigation education directly influences junior high school students' understanding and practical utilization of evacuation routes in tsunami-prone coastal areas.

Based on the preceding discussion, a research gap exists regarding the limited quantitative research analyzing the impact of earthquake and tsunami mitigation education on junior high school students' understanding of evacuation route usage, particularly in Puring District, an area

highly vulnerable to tsunamis. This study not only describes students' levels of understanding and the implementation of disaster mitigation education but also examines the relationship between these two variables, thereby providing empirical evidence regarding the effectiveness of school-based disaster mitigation education.

Therefore, this study aims to assess the level of understanding among junior high school students in Puring District regarding the use of earthquake and tsunami evacuation routes, analyze the implementation of earthquake and tsunami disaster mitigation education, and examine the impact of such education on students' understanding of evacuation route usage. The findings are expected to contribute scientifically to the development of disaster mitigation education studies and serve as a basis for schools, local governments, and disaster management agencies to formulate policies, design educational programs, and strengthen the implementation of "Disaster-Safe Schools" tailored to the specific hazard characteristics of Puring District.

2. Literature Review

2.1 Understanding the Use of Evacuation Routes

Comprehension refers to an individual's ability to grasp and understand a concept after having been introduced to and having memorized it. According to Ayuwardani (2023), comprehension is a behavior demonstrating a learner's ability to grasp the meaning of a concept, enabling them not only to recall information but also to view the concept from various perspectives. Comprehension encompasses the ability to translate, interpret, summarize, or extrapolate a concept using one's own choice of words or symbols (Sari et al., 2024). Aligning with this view, Yusniati et al (2018) states that comprehension is a learner's ability to grasp the meaning of material, thereby enabling them to explain the learned concept in detail using their own language. Thus, comprehension indicates that the learning process has fostered a depth of thinking that goes beyond the mere memorization of information (Ayuwardani, 2023).

According to Bloom (Yusniati et al., 2016), comprehension is the ability to grasp the meaning of material, demonstrated by the capacity to restate information in an easily understandable form, provide interpretations, and classify learned concepts. Bloom categorizes comprehension as a cognitive skill requiring learners to process information so that it becomes meaningful and applicable in various situations. In the context of disaster mitigation education, comprehension is a crucial aspect; learners are required not only to be aware of the existence of evacuation routes but also to understand their functions, the relevant procedures, and the specific actions to take when facing the threat of earthquakes and tsunamis.

Bloom categorizes comprehension into three aspects: translation, interpretation, and extrapolation (Sari et al., 2022). The translation aspect refers to the ability to convert abstract concepts into more easily understood forms, for example, explaining the meaning of symbols or evacuation route signs in one's own words. The interpretation aspect involves the ability to grasp the main idea of information, explain relationships between pieces of information, and assign meaning to the concepts being studied, such as interpreting an evacuation route map and determining the appropriate route during an earthquake and tsunami (Limehuwey et al., 2026). Meanwhile, the extrapolation aspect is the ability to draw conclusions or predict conditions based on understood information, for instance, anticipating the necessary actions if the primary evacuation route becomes unusable due to the impact of a disaster.

This study employs Bloom's theory of comprehension as a theoretical framework to measure students' understanding of evacuation route usage within the context of earthquake and tsunami disaster mitigation education. Bloom's three aspects of comprehension serve as the basis for formulating research indicators: the students' ability to interpret the meaning of evacuation route symbols, decipher information on maps and evacuation signs, and anticipate appropriate

self-rescue actions based on potential disaster scenarios. By applying this theory, the students' level of understanding is assessed not merely by their ability to recall information, but also by their capacity to comprehend, explain, and apply that knowledge in real-world situations. A higher level of understanding regarding evacuation routes increases the likelihood of students acting quickly, accurately, and safely, thereby minimizing the risk of casualties resulting from earthquakes and tsunamis.

2.2 Disaster Mitigation Education

Disaster mitigation encompasses a series of efforts aimed at reducing disaster risk, achieved through both physical infrastructure development and the enhancement of community awareness and capacity to face disaster threats. Under Law Number 24 of 2007 concerning Disaster Management, mitigation aims to minimize the impact of disasters, thereby reducing loss of life, property damage, and environmental degradation. One effective form of mitigation implementation is through school-based education. Disaster mitigation education not only imparts knowledge regarding the types, causes, and impacts of disasters but also fosters student preparedness, enabling them to act appropriately during emergencies. Consequently, schools play a strategic role as a platform for cultivating a disaster-aware culture from an early age.

The objective of school-based disaster mitigation education is to enhance students' knowledge, attitudes, and skills in dealing with disaster threats. The National Agency for Disaster Countermeasure (BNPB, 2007) states that mitigation education aims to improve students' understanding of various disaster types and their associated risks; foster awareness of the importance of environmental preservation as a disaster risk reduction measure; shape disaster-responsive attitudes and behaviors through instruction and simulations; and enhance the capacity of the entire school community to undertake prevention, preparedness, emergency response, and post-disaster recovery actions (BMKG, 2021; Komara et al., 2026). Furthermore, UNESCO (2012) emphasize that sustained mitigation education can boost student resilience, equipping them with the ability to make rapid and accurate decisions when a disaster occurs.

The implementation of mitigation education in schools is realized through the Disaster-Safe Education Unit (SPAB) program, which is developed based on three main pillars (Komara et al., 2026). The first pillar concerns disaster-safe facilities, specifically providing a safe physical school environment through buildings that meet safety standards and the availability of supporting infrastructure such as evacuation routes, signage, assembly points, and safety equipment. The second pillar involves school disaster management, encompassing policy formulation, the establishment of disaster preparedness teams, contingency planning, the conduct of drills, and mechanisms for emergency response and post-disaster recovery. The third pillar focuses on disaster prevention and risk reduction education, involving instruction aimed at building the knowledge, attitudes, and skills of the school community regarding disaster causes, mitigation measures, evacuation procedures, and actions to be taken before, during, and after a disaster.

In this study, the three pillars of the Disaster-Safe Education Unit serve as the conceptual framework for analyzing the implementation of earthquake and tsunami mitigation education in public junior high schools (*SMP Negeri*) within Puring District (BNPB, 2007; Komara et al., 2026; UNESCO, 2012). The disaster-safe facilities pillar is examined through the presence and utilization of evacuation routes and their supporting infrastructure within the school grounds (Maharani et al., 2026; Soviana et al., 2025; Tarihoran et al., 2025). The disaster management pillar is analyzed based on the implementation of preparedness programs, evacuation drills, and disaster management practices by the schools (Annisah et al., 2025; Komara et al., 2026; Rumtutuly et al., 2026). Meanwhile, the disaster prevention and risk reduction education pillar

serves as the primary focus for assessing the mitigation education provided to students (Limehuwey et al., 2026; Puspitasari et al., 2021; Tambunan et al., 2026). Finally, these three pillars are linked to students' understanding of evacuation route usage to determine the extent to which the implementation of disaster mitigation education enhances student preparedness in facing the threats of earthquakes and tsunamis (Ayuwardani, 2023; Sari et al., 2024).

3. Research Methodology

3.1 Research Design

This study employs a quantitative approach with a descriptive research design. The quantitative approach was selected because it focuses on measuring variables based on numerical data, analyzed using statistical techniques, to examine phenomena objectively. Quantitative research is grounded in assumptions that are formulated into research variables and analyzed using valid methods (Abdullah et al., 2022). Winarno (2013) states that quantitative research applies a scientific thought process through logical-hypothetic-verificative stages. The descriptive design is utilized to provide a systematic, factual, and objective overview of students' understanding regarding the use of evacuation routes and the implementation of earthquake and tsunami mitigation education, as well as the influence of such education on students' understanding of evacuation route usage in state junior high schools (SMP Negeri) in Puring District. Under this design, data are collected via research instruments, analyzed statistically, and subsequently interpreted to produce an accurate description aligned with the study's objectives.

3.2 Participants

Based on the calculations above, the study population consists of 1.233 students from SMP Negeri 1 Puring and SMP Negeri 2 Puring. The sample size was determined using Slovin's formula with a 10% margin of error, resulting in a total sample of 93 respondents. Subsequently, the sample was allocated proportionally based on the student population of each school. The calculations yielded a sample of 50 respondents from SMP Negeri 1 Puring and 43 respondents from SMP Negeri 2 Puring, bringing the total study sample to 93 respondents.

3.3 Instruments

The research instrument employed in this study is a structured questionnaire designed in accordance with quantitative instrument development principles (Abdullah et al., 2022; Winarno, 2013). The questionnaire consists of written statements formulated on a 5-point Likert scale to gather empirical data from public junior high school (*SMP Negeri*) students in Puring District. To ensure construct and content validity, the measurement indicators for both variables were adapted from established prior studies. Specifically, the indicators for the implementation of disaster mitigation education were adapted from school-based disaster preparedness and policy frameworks (Komara et al., 2026; Puspitasari et al., 2021). Meanwhile, the indicators for students' understanding of evacuation route usage were adapted from prior research evaluating route comprehension and student conceptual readiness in disaster-prone areas (Annisah et al., 2025; Sari et al., 2024; Soviana et al., 2025). The questionnaire was selected because it enables systematic, objective, and efficient data collection, allowing the results to be analyzed quantitatively to describe each variable and examine the influence of mitigation education on evacuation route comprehension

3.4 Data Analysis Procedures

The data obtained in this study were analyzed using descriptive statistics and simple linear regression with a partial test (*t*-test) following standard quantitative analysis procedures (Abdullah et al., 2022). Descriptive statistics were employed to characterize the students' level of understanding regarding the use of evacuation routes and the implementation of earthquake and tsunami disaster mitigation education, presenting the results through mean values, percentages, and assessment categories. Subsequently, hypothesis testing was conducted using a partial test (*t*-test) to determine the effect of disaster mitigation education on students' understanding of evacuation route usage. Prior to hypothesis testing, the data satisfied the prerequisite statistical tests, specifically normality and linearity tests. All data processing and statistical procedures were executed using IBM SPSS Statistics software to ensure computational accuracy and scientific validity

4. Findings

4.1 Understanding the Use of Earthquake and Tsunami Evacuation Routes

a. Indicator Translation

Translation	%	Category
Item 1	67%	High
Item 2	65%	High
Item 3	68%	High
Item 4	62%	High
Average	66%	High

Source: Research Data (2026)

The translation indicator achieved a score of 66%, placing it in the high category. The findings indicate that students possess an adequate understanding of the concept of evacuation routes and the function of evacuation signs within the school environment. Conceptual understanding represents a crucial initial stage in disaster mitigation education, as students must grasp the meaning and purpose of available mitigation facilities before they can apply them in real-life situations.

b. Indicator Interpretation

Interpretation	%	Category
Item 1	64%	High
Item 2	59%	Medium
Item 3	62%	High
Item 4	64%	High
Average	62%	High

Source: Research Data (2026)

Regarding the interpretation indicator, the obtained result of 62% falls within the high range. This indicates that students are capable of interpreting evacuation route directions and determining the appropriate route during an emergency. However, one sub-indicator was classified in the moderate category, with a score of 59 percent. This suggests that some students do not yet fully understand the decision-making procedures involved in an evacuation.

c. Extrapolation Indicator

Extrapolation	%	Category
Item 1	66%	High
Item 2	67%	High
Item 3	67%	High
Item 3	64%	High
Average	66%	High

Source: Research Data (2026)

The extrapolation indicator achieved the highest percentage among the indicators (66%), placing it in the "high" category. These results demonstrate that students possess a strong ability to determine the appropriate actions to take during an earthquake or tsunami. Such capability is crucial for disaster mitigation, as making the right decisions quickly can minimize the risk of fatalities during a disaster. Consequently, students not only understand information regarding evacuation routes but are also able to relate this knowledge to the specific actions required based on the situation at hand.

4.2 Implementation of Earthquake and Tsunami Mitigation Education for Junior High School Students in Puring District

a. Indicators of Safe Educational Unit Facilities

Safe Education Unit Facilities	%	Category
Item 1	79%	High
Item 2	68%	High
Item 3	72%	High
Item 4	66%	High
Item 5	75%	High
Item 6	68%	High
Average	66%	High

Source: Research Data (2026)

The indicator for safe educational facility amenities recorded the highest percentage among all indicators, 71%, placing it in the "high" category. These results indicate that students possess a good understanding of the evacuation routes, evacuation signage, and assembly points available within the school environment.

b. Disaster Management Indicators

Disaster Management	%	Category
Item 1	71%	High
Item 2	64%	High
Item 3	69%	High
Item 4	63%	High
Item 5	70%	High
Item 6	60	Medium
Average	66%	High

Source: Research Data (2026)

Regarding the indicator for disaster management in schools, a score of 66% was recorded, placing it in the high category. These results indicate that the majority of students understand evacuation procedures, early warning systems, and the roles of the school community during a

disaster. However, one sub-indicator, specifically concerning the role of the school community during disaster situations, remains in the medium category, with a score of 60 percent.

c Disaster Risk Prevention and Reduction Education

Disaster Risk Prevention and Reduction Education	%	Category
Item 1	72%	High
Item 2	68%	High
Item 3	65%	High
Item 4	58%	Medium
Item 5	64%	High
Item 6	63%	High
Average	63%	High

Source: Research Data (2026)

Meanwhile, the indicator for disaster risk prevention and reduction education achieved a score of 65%, placing it in the high category. The research findings indicate that students possess a reasonably good understanding of disaster mitigation concepts and the actions required before, during, and after a disaster. However, one sub-indicator related to mitigation actions showed an achievement level in the moderate category, with a score of 58 percent. These results indicate that disaster mitigation education for students still requires further development through more interactive and contextual learning approaches. Delivering mitigation material combined with field simulations, digital learning media, and project-based learning can enhance the effectiveness of disaster mitigation instruction within the school environment.

4.3 The Influence of Earthquake and Tsunami Mitigation Education on the Understanding of Evacuation Route Usage among Public Junior High School Students in Puring District.

In the context of disaster education, enhancing such understanding is inseparable from the educational process delivered by educational institutions through various forms of disaster mitigation learning. Therefore, this study was conducted to determine the extent to which the implementation of disaster mitigation education influences students' understanding of how to use evacuation routes during earthquakes and tsunamis. Based on the simple linear regression analysis, the regression equation obtained is $Y = 42.044 + 0.488X + e$. The positive regression coefficient indicates a positive relationship between the earthquake and tsunami mitigation education variable and the variable regarding the understanding of evacuation route usage. The obtained significance value is 0.000, which is lower than the significance level of 0.05. Consequently, the alternative hypothesis (Ha) is accepted, meaning that earthquake and tsunami mitigation education significantly influences the understanding of evacuation route usage among public junior high school students in Puring District.

The coefficient of determination test results shows an R-Square value of 0.359, or 35.9 percent. These results indicate that the earthquake and tsunami mitigation education variable accounts for 35.9 percent of the influence on the understanding of evacuation route usage, while the remaining 64.1 percent is influenced by factors not examined in this study. The magnitude of the influence demonstrated in this study indicates that school-based disaster mitigation education serves not merely as a means of imparting knowledge but can play a strategic role in fostering a disaster-aware culture among students.

5. Discussion

The research results indicate that students' level of understanding regarding the use of evacuation routes falls into the high category. This finding suggests that the disaster mitigation education implemented in public junior high schools in Puring District has successfully enhanced students' understanding of the functions, procedures, and utilization of evacuation routes during earthquakes and tsunamis. This aligns with cognitive learning concepts showing that structured material delivery directly improves student comprehension and conceptual mastery (Ayuwardani, 2023; Sari et al., 2024). In coastal disaster contexts, clear understanding of evacuation routes is essential so that students can recognize safe assembly points and estimate travel times during sudden tsunami threats (Soviana et al., 2025; Tarihoran et al., 2025). Nevertheless, cognitive knowledge alone is insufficient during real emergencies; thus, practice-based learning, such as periodic evacuation simulations and drills, remains vital to turn theoretical concepts into practical decision-making skills (Annisah et al., 2025; Rumtutuly et al., 2026). In summary, while theoretical understanding of evacuation routes among students is already high, regular physical simulations are still required to translate this cognitive knowledge into swift, life-saving actions.

The study also reveals that the implementation of earthquake and tsunami mitigation education in public junior high schools in Puring District ranks in the high category. This indicates that mitigation education has been effectively delivered through various learning activities and efforts to boost student preparedness. These results reinforce previous research findings stating that structured disaster mitigation education plays a crucial role in building student awareness and resilience in disaster-prone coastal areas (Limehuwey et al., 2026; Puspitasari et al., 2021; Tambunan et al., 2026). To sustain this effectiveness, school activities should align with national disaster safety policies, particularly the Disaster-Safe Education Unit (SPAB) framework (BNPB, 2007). Furthermore, maintaining high implementation standards requires continuous administrative support, innovative learning media, and routine drills to ensure mitigation becomes an ingrained part of school culture rather than a passive instructional topic (Komara et al., 2026). Overall, a high level of disaster education implementation serves as a crucial foundation, yet it must be continuously supported by institutional policy and interactive media to ensure long-term school preparedness.

The finding that disaster mitigation education positively and significantly influences students' understanding of evacuation route usage contributes both theoretically and practically to disaster education. Theoretically, this study confirms that targeted mitigation education is a key determinant in improving spatial awareness and route familiarity among students in hazard-prone zones (Maharani et al., 2026; Soviana et al., 2025; Tarihoran et al., 2025). Practically, the results underscore the strategic role schools play in transforming abstract disaster concepts into functional survival skills through integrated learning and regular simulation practice (Annisah et al., 2025; Limehuwey et al., 2026). Consequently, these empirical insights offer a solid foundation for schools and local policymakers in Puring District to design mitigation programs that are contextual, effective, and sustainable. Ultimately, strengthening both the quality and delivery of mitigation education is proven to directly elevate students' practical capacity to navigate evacuation routes safely during an actual disaster.

6. Conclusion

Overall, the research data indicate that the implementation of earthquake and tsunami disaster mitigation education at public junior high schools (*SMP Negeri*) in Puring District falls into the high category. This demonstrates that the school-based mitigation program has been effectively conducted, successfully equipping students with fundamental knowledge and preparedness for potential disaster events. In line with these implementation efforts, students' level of understanding regarding the function, procedures, and practical use of evacuation routes also reached a high category. The findings suggest that the educational activities delivered in schools have contributed positively to enhancing students' spatial knowledge and self-preservation awareness when facing potential coastal hazards.

Based on the research findings, data analysis, and discussion presented, it can be concluded that earthquake and tsunami disaster mitigation education has a significant positive impact on students' understanding of evacuation route usage at state junior high schools in Puring District. The results show that the more effectively disaster mitigation education is delivered, the higher the students' level of understanding regarding the functions, procedures, and use of evacuation routes as a means of self-preservation during emergency situations.

However, this study has two notable limitations. First, the scope of this research was restricted to public junior high schools within a single administrative district (Puring District), which may limit the generalizability of the findings to private institutions or other coastal regions with different topographic and infrastructural conditions. Second, the measurement relied primarily on self-reported questionnaires focusing on cognitive comprehension, rather than direct observation of students' physical behaviour during an actual evacuation exercise.

To build upon these findings, future research should expand the geographic scope and sample diversity by incorporating elementary and senior high schools across different coastal areas. Furthermore, subsequent studies are recommended to utilize mixed-methods or experimental designs that combine self-reported surveys with practical performance evaluations during real-time evacuation simulations.

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