



DEVELOPMENT AND EVALUATION OF A SPATIAL-BASED GEOGRAPHY MODULE FOR DISASTER MITIGATION LEARNING AMONG GRADE XI MADRASAH ALIYAH STUDENTS

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Abstract. This study aimed to develop and evaluate a spatial-based Geography module for disaster mitigation learning among Grade XI students at MA Siti Fatimah, Pandaan, Pasuruan Regency. The study employed a research and development (R&D) approach adapted from the Borg and Gall model and consisting of seven stages. Module validity was assessed by a subject matter expert, a language expert, and a media expert, while practicality was evaluated through teacher and student response questionnaires. Effectiveness was examined using a quasi-experimental nonequivalent control group design involving 42 students: 21 in the experimental class and 21 in the control class. Data were collected through expert validation sheets, response questionnaires, learning outcome tests, interviews, and observations. The data were analyzed using descriptive quantitative and qualitative techniques, normalized gain analysis, and an independent-samples t-test. The module obtained validity scores of 61% for subject matter, 82% for language, and 77% for media. Teacher and student response scores were 85% and 84.28%, respectively. The experimental and control classes achieved normalized gain scores of 0.8617 and 0.6268, respectively, indicating high and medium learning improvement. The independent-samples t-test showed a statistically significant difference between the groups, $t(36.59) = 45.95$, $p < .001$; the mean posttest scores of the experimental and control classes were 93.57 and 82.81, respectively. Overall, the findings support the use of the developed module as a supplementary instructional resource for disaster mitigation learning. Further research involving larger samples and multiple schools is needed to examine the generalizability of these findings.

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INTRODUCTION

Indonesia lies at the convergence of the Indo-Australian and Pacific tectonic plates. This geological setting makes the country highly prone to earthquakes, tsunamis, volcanic eruptions, floods, and landslides. In such an environment, disaster mitigation education is essential. It helps students recognize the hazards Indonesia faces and teaches them how to act to reduce losses (Ramli et al., 2025). When students study disaster risks, they can interpret disaster information more clearly and relate what they learn to Indonesia's geographical conditions. Disaster mitigation should therefore not be taught as a list of facts; rather, it should be a subject in which students examine how geography relates to hazards and how communities in Indonesia can prepare for them. Such an approach deepens students' understanding and provides hands-on learning experiences (Atmojo, 2021; Kamil et al., 2020).

Geography education provides a strong foundation for disaster mitigation because it examines where phenomena are located, how they are distributed, how they are arranged, and how they relate to one another on the Earth's surface. To understand disaster hazards, students need to consider not only what the hazard is but also where it occurs and how the geography of a place influences its impact. Spatial thinking is therefore especially important. National Research Council (2006) describes spatial thinking as a combination of spatial concepts, tools of representation, and processes of reasoning. In Geography classes, these components can be

applied through maps, spatial visualizations, and the analysis of spatial information. In disaster mitigation learning, they can help students locate hazards, compare different areas, and examine how environmental conditions relate to disaster likelihood. Spatial thinking can thus provide a framework for designing lessons that link spatial representations with reasoning about disasters (Dessen Jankell et al., 2021; Goodchild & Janelle, 2010).

Although spatial thinking skills are important in Geography education, teaching materials that support them remain limited and underused in classrooms. Preliminary observations and interviews at MA Siti Fatimah, Pandaan, Pasuruan Regency, showed that Geography lessons relied mainly on textbooks and student worksheets (Lembar Kerja Siswa, LKS). These materials were largely text-based and contained few visuals. According to the needs analysis, they did not include maps or images of disaster-prone areas, nor did they offer activities in which students could practice reading and interpreting data. As a result, students had few opportunities to connect written information about disaster mitigation with actual maps or real conditions in specific places (Tomaszewski et al., 2020). Hence, learning materials are needed that present disaster mitigation concepts through more contextual and location-based activities. This need is consistent with research showing that geographic literacy and contextual learning help students better understand disaster-related topics (Kamil et al., 2020; Kusuma et al., 2025).

Previous studies have explored ways to strengthen Geography learning and disaster education. For example, Handoyo and Susilo (2020) examined a spatial-based Geography textbook combined with the 5E learning cycle. Ayuningtyas and Irawan (2024) examined a spatial-based learning model for improving high school students' geographic skills and disaster literacy. Prasetya et al. (2025) examined disaster map-based worksheets for improving students' understanding of disaster mitigation in social science subjects. These studies show that spatially oriented learning materials and activities have already been investigated in various instructional settings. However, the materials and methods used in these studies differ in structure and focus. This provides a rationale for developing a module that combines maps, visual representations of disaster-prone areas, real-life disaster cases, and spatial analysis activities in a single Geography learning resource for Grade XI students at a Madrasah Aliyah. The rationale for this study is not that spatial-based disaster learning has never been studied, but that a new module is needed to meet the specific instructional needs of the research site. Such a module needs to be developed and tested.

To address this need, this study developed a spatial-based Geography module for disaster mitigation learning among Grade XI students at MA Siti Fatimah, Pandaan, Pasuruan Regency. The module uses maps, images of places, and disaster case narratives to help students learn how to stay safe. Students practice reading maps, interpreting images, and solving problems that connect geography with disaster mitigation. The design of the module draws on the National Research Council's framework of spatial thinking, which encompasses spatial concepts, tools of representation, and processes of reasoning (Subhani et al., 2017). In this study, spatial thinking serves as a guiding principle for the module design rather than as a measured outcome. The module was tested in the classroom at MA Siti Fatimah to examine how its components work together and how they help Grade XI students understand disaster mitigation.

This study aimed to develop and test a spatial-based Geography module for disaster mitigation learning among Grade XI students at MA Siti Fatimah, Pandaan, Pasuruan Regency. Three aspects were examined: first, the module's validity, as judged by subject matter, language, and media experts; second, its practicality, based on teacher and student responses; and third, its effectiveness, measured by comparing a class that used the module with a control class that used the school's existing teaching materials. By examining these three aspects, the study determines whether the module is feasible and useful in classrooms and whether it improves students' Geography learning outcomes, thereby positioning it as a useful supplementary resource for disaster mitigation education (Kamil et al., 2020; Menoni et al., 2012).



RESEARCH METHODS

This study employed a research and development (R&D) design to develop and test a spatial-based Geography module for disaster mitigation learning among Grade XI students at MA Siti Fatimah, Pandaan, Pasuruan Regency, Indonesia, in the 2025/2026 academic year. The procedure was adapted from the Borg and Gall model (Borg & Gall, 1983), whose ten stages (Muthoharoh & Marmoah, 2025) were condensed into seven: (1) research and information collecting, (2) planning, (3) development of the preliminary product, (4) preliminary field testing, (5) product revision, (6) field testing, and (7) final product revision. The dissemination and implementation stages were omitted to fit the study's objectives and resources. Because the module was tested in only one school, the findings are limited to that setting.

The developed product was a supplementary spatial-based Geography module containing thematic maps, spatial visualizations, disaster-related case studies, spatial analysis activities, exercises, and learning assessments. These components were designed to help students connect spatial patterns with disaster mitigation problems. A needs analysis based on observations and interviews with the Geography teacher and students informed the preliminary version, which was then reviewed and revised based on feedback from a subject matter expert, a language expert, and a media expert. The revised module was field-tested with 42 Grade XI students in two intact classes: an experimental class ($n = 21$) that used the module and a control class ($n = 21$) that used the school's existing materials. Both classes completed a pretest and a posttest.

Data were collected using expert validation sheets, teacher and student response questionnaires, learning outcome tests, interview guidelines, and observation sheets. The validation sheets assessed the module's content, language, and media presentation. The questionnaires measured its perceived practicality, and the pretest and posttest measured students' learning outcomes on disaster mitigation. Interviews and observations supported the initial needs analysis. Each validation aspect was assessed by a single expert, so the results reflect individual expert judgment rather than inter-rater agreement.

Validation and questionnaire scores were calculated as percentages (obtained score $\div$ maximum score $\times 100\%$) and interpreted using the validity and practicality criteria established for this study. Qualitative data from expert comments, interviews, and observations were used to identify instructional needs and guide module revision. Effectiveness was examined using the normalized gain (N-Gain) formula of Hake (1998), with gains categorized as high (≥ 0.70), medium ($0.30-0.70$), or low (< 0.30). After data normality was checked, the difference in N-Gain between the experimental and control classes was tested using Welch's independent-samples t-test at the .05 significance level.

RESULTS AND DISCUSSION

1. Development of the Spatial-Based Geography Module for Disaster Mitigation Learning

The development process produced a spatial-based Geography module for disaster mitigation learning designed for Grade XI students at MA Siti Fatimah, Pandaan, Pasuruan Regency. The module was developed by adapting the Borg and Gall model into seven stages: research and information collecting, planning, development of the preliminary product, preliminary field testing, product revision, field testing, and final product revision. The initial stage involved a needs analysis based on observations and interviews with the Geography teacher and students to identify learning problems and instructional material needs.

The needs analysis indicated that Geography learning relied predominantly on conventional textbooks and student worksheets (LKS), which were largely text-based. The existing teaching materials did not adequately integrate spatial visualizations that could help students understand the distribution of geographical phenomena and their relationships with potential disaster risks. Consequently, students had difficulty connecting disaster mitigation concepts with the geographical characteristics of the areas being studied.



Based on these findings, a spatial-based Geography module was developed by integrating thematic maps, spatial illustrations, disaster-related case studies, student learning activities, spatial analysis exercises, and learning assessments. The module was designed according to contextual learning principles to enable students to connect the learning content with real conditions in their surrounding environment (Lase et al., 2026).

The integration of a spatial approach is consistent with the nature of Geography as a discipline that emphasizes the analysis of location, distance, spatial patterns, and relationships among phenomena on the Earth's surface. Through this approach, students were expected not only to understand disaster mitigation concepts theoretically but also to identify the distribution of disaster-prone areas, analyze factors contributing to disaster risk, and determine appropriate mitigation measures based on specific geographical conditions. This design is consistent with Handoyo and Susilo (2020), who reported that spatial-based learning can strengthen students' understanding of geographical phenomena through the interpretation of spatial data.

In addition to presenting conceptual content, the module incorporated simple observation activities, map analysis, image interpretation, and disaster-related case studies that encouraged students to engage in analytical and critical thinking (Mike et al., 2026). This variety of learning activities was intended to increase student engagement while developing spatial thinking skills, which are an important competency in Geography learning (Shin & Bednarz, 2018).

The resulting module was designed as a supplementary instructional resource that integrates disaster mitigation content with a spatial approach through the use of maps, spatial visualizations, and regional analysis activities. The cover of the developed module is presented in Figure 1.



Figure 1. Cover of the Spatial-Based Geography Module for Disaster Mitigation Learning

The module cover was designed to reflect the learning theme, the students' characteristics, and the content of the developed instructional material. Visual elements related to disasters and spatial phenomena were incorporated to preview the module content and attract students' attention. In addition to serving as the product's visual identity, the cover design was part of the media design component evaluated during the validation process.

2. Characteristics of the Spatial-Based Geography Module

The developed spatial-based Geography module was designed as a self-directed instructional resource that students can use both during classroom learning and for independent study outside the classroom (Shi et al., 2020). The module was developed with consideration of the characteristics of disaster mitigation content and students' learning needs, particularly their need to understand geographical phenomena in relation to spatial conditions. Therefore, the module does not merely present conceptual information; it also incorporates various learning components that facilitate students' understanding of the relationship between geographical characteristics and potential disaster risks.

The module consists of three main parts: an introductory section, a main content section, and a closing section. The introductory section includes the cover, preface, table of contents, instructions for using the module, learning outcomes, learning objectives, and a concept map. The instructions guide students through the learning activities and facilitate independent use of the module. The concept map provides an overview of the disaster mitigation topics and illustrates the relationships among the concepts presented in the module, as shown in Figure 2.



Figure 2. Concept Map of the Spatial-Based Geography Module

As shown in Figure 2, the disaster mitigation content is organized hierarchically, beginning with basic disaster concepts and proceeding to types of disasters, causal factors, disaster-prone areas, and mitigation measures to be taken before, during, and after a disaster. This systematic organization enables students to develop their understanding progressively, from basic to more complex concepts. The relationships among the concepts in the map also emphasize that disaster mitigation is closely associated with the geographical characteristics and spatial conditions of an area.

A distinctive feature of the module is the integration of activities that require students to interpret and analyze spatial information independently. These activities are designed to engage students in observing, interpreting, comparing, and analyzing spatial information related to disaster phenomena. An example of the spatial-based content and learning activity is presented in Figure 3.

Di samping bencana geologi dan hidrometeorologi, Indonesia juga menghadapi berbagai bencana nonalam, seperti pandemi, kegagalan teknologi, kecelakaan industri, serta bencana yang dipengaruhi oleh aktivitas manusia. Meningkatnya jumlah penduduk, perkembangan kawasan permukiman, perubahan tata guna lahan, dan perubahan iklim turut meningkatkan tingkat kerentanan masyarakat terhadap berbagai ancaman bencana.

Gambar 1.1 Peta Risiko Bencana Indonesia Tahun 2025



Sumber: Badan Nasional Penanggulangan Bencana (BNPB), 2025

Berdasarkan data Badan Nasional Penanggulangan Bencana (BNPB), kejadian bencana di Indonesia setiap tahun masih didominasi oleh bencana hidrometeorologi, seperti banjir, cuaca ekstrem, dan tanah longsor. Sementara itu, ancaman gempa bumi, tsunami, dan letusan gunung api tetap menjadi risiko besar karena kondisi geologi Indonesia yang berada pada jalur Ring of Fire. Oleh sebab itu, pemahaman mengenai karakteristik bencana dan upaya mitigasinya menjadi sangat penting agar masyarakat memiliki kesiapsiagaan yang lebih baik dalam menghadapi berbagai ancaman bencana.

Pendidikan mitigasi bencana merupakan salah satu strategi yang efektif untuk membangun budaya sadar bencana sejak dini. Melalui pembelajaran mitigasi bencana, peserta didik diharapkan tidak hanya memahami jenis dan penyebab

Figure 3. Example of Spatial-Based Content and Learning Activity

The activities provide opportunities for students to participate actively in the learning process. Rather than acquiring information solely through reading, students are guided to interpret spatial information and solve problems based on the data and representations provided in the module.

The main content section presents disaster mitigation material systematically, covering basic concepts of disaster mitigation, types of disasters, causal factors, disaster-prone areas, and mitigation measures before, during, and after disasters. The content is organized progressively to facilitate students' understanding, moving from fundamental to more complex concepts. Examples drawn from real-life situations and geographical conditions in Indonesia are also incorporated to provide contextual learning experiences.

The defining characteristic of the module is its integration of a spatial approach into the presentation of disaster mitigation content. This approach is implemented through thematic maps, spatial illustrations, visual representations of disaster-prone areas, and learning activities that involve analyzing the location and distribution of disaster phenomena (Prasetya et al., 2025). These components enable students to examine the spatial characteristics of different types of disasters and their relationships with the geographical conditions of particular areas. Consequently, disaster mitigation is presented not only as a set of theoretical concepts but also as a process of understanding and responding to disaster risks based on spatial conditions.

Thematic maps are an important component of the module because they visually represent the spatial distribution of disaster phenomena. Through map-based activities, students are guided to identify disaster-prone locations, examine distribution patterns, and analyze relationships between physical geographical conditions and potential disaster risks. Map interpretation activities also give students opportunities to compare spatial information and draw conclusions based on the evidence presented.

In addition to thematic maps, the module incorporates various spatial analysis activities, including map interpretation, identification of disaster-prone areas, analysis of disaster-related factors based on geographical conditions, and case studies of disasters occurring in Indonesia. These activities are designed to engage students in analyzing spatial information and applying geographical concepts to disaster-related problems.

The module also contains student activity sheets that support the application of the concepts learned through structured learning tasks. Students are guided to observe phenomena, gather information, analyze simple data, and formulate conclusions. These activities position

students as active participants in the learning process rather than as passive recipients of information.

Each learning unit concludes with a summary of key concepts, followed by exercises and assessment activities. The questions are designed not only to assess students' conceptual understanding but also to require them to analyze situations and determine appropriate solutions based on specific geographical conditions. The closing section contains a final evaluation, a glossary, and references. The glossary explains geographical and disaster-related terms that may be unfamiliar to students, while the references list the academic sources used in developing the module content.

Overall, the integration of conceptual content, spatial visualizations, thematic maps, and spatial analysis activities distinguishes the developed module from conventional text-oriented instructional materials. The module provides students with opportunities to connect disaster mitigation concepts with the geographical characteristics and spatial conditions of particular areas. These characteristics make the spatial-based Geography module a potentially useful supplementary instructional resource for Geography learning and disaster mitigation education at the Grade XI level.

3. Validity of the Spatial-Based Geography Module

The validity of the developed spatial-based Geography module was assessed by three experts: a subject matter expert, a language expert, and a media expert. The validation results are presented in [Table 1](#).

Table 1. Validation Results of the Spatial-Based Geography Module

Validator	Percentage (%)	Category
Subject matter expert	61	Feasible
Language expert	82	Very feasible
Media expert	77	Feasible

As shown in [Table 1](#), the module received validation scores of 61% for subject matter, 82% for language, and 77% for media presentation. Language received the highest score, whereas subject matter received the lowest, indicating that the experts' assessments differed across the three validation aspects. The scores were interpreted as feasibility categories based on the criteria described in the Research Methods section. Clear, simple, and age-appropriate language is particularly important in instructional materials intended to support both classroom and independent learning ([Nguyen, 2021](#)).

The subject matter expert recommended refining the disaster case studies and adding more contextual information about the geography of disaster-prone areas. These suggestions were incorporated into the module revision to strengthen the module's relevance. The language score reflects an assessment of the appropriateness of the module's language for Grade XI students. The media score reflects the evaluation of the module's presentation components, such as thematic maps and spatial illustrations. These visual elements are important in Geography learning because they show the location and distribution of disaster phenomena in relation to geographical conditions.

The integration of spatial representations into Geography learning is consistent with the findings of [Wahyuningtyas et al. \(2021\)](#). Nevertheless, because each validation aspect was assessed by only one expert, the results represent individual judgments rather than inter-rater agreement. The validation findings therefore provide an assessment of the module's content, language, and presentation while also highlighting areas for refinement before or during instructional implementation.

4. Practicality of the Spatial-Based Geography Module

The practicality of the developed spatial-based Geography module was assessed based on the responses of the Geography teacher and Grade XI students after the module was implemented. The results of the practicality assessment are presented in [Table 2](#).



Table 2. Practicality Results of the Spatial-Based Geography Module

Respondent	Percentage (%)	Category
Geography teacher	85.00	Very good
Students	84.28	Very good

The practicality of the module was measured using questionnaires completed by the Geography teacher and the students. Table 2 shows that the teacher response score was 85.00%, while the student response score was 84.28%. Both scores fell into the “very good” category according to the predetermined practicality criteria, indicating that the module was received positively in the learning setting.

The Geography teacher considered the module well organized and found that the thematic maps, spatial visualizations, and analysis tasks helped explain disaster mitigation concepts. The students reported that the module combined images with a variety of learning activities, giving them opportunities to work with maps and analyze disaster cases. These qualities suggest that the module was well received by both the teacher and the students. This finding is consistent with studies reporting that learners respond positively to instructional materials designed for their learning needs (Bachri et al., 2024; Putri et al., 2026).

Overall, the response scores indicate that the participants perceived the module as practical and received it favorably. However, these results reflect only users’ perceptions and do not demonstrate improved learning, which was examined in a separate analysis of learning outcomes.

5. Effectiveness Based on Normalized Gain Analysis

The effectiveness of the spatial-based Geography module was examined by comparing normalized learning gains (N-Gain) between two groups, the experimental class and the control class, each consisting of 21 students. The results are presented in Table 3.

Table 3. Normalized Gain Scores of Students’ Learning Outcomes

Class	Number of Students	Mean N-Gain	Category
Experimental	21	0.8617	High
Control	21	0.6268	Medium

Note. Categories are based on Hake (1998).

Using Hake’s (1998) criteria, the experimental class’s mean N-Gain of 0.8617 falls into the high category, whereas the control class’s mean N-Gain of 0.6268 falls into the medium category. The difference between the two means is 0.2349 in favor of the experimental class. In other words, the experimental class showed greater learning improvement than the control class.

Before the intervention, the mean pretest scores were 53.43 for the experimental class and 53.90 for the control class. These similar values indicate a comparable starting point. After the intervention, the mean posttest scores were 93.57 for the experimental class and 82.81 for the control class. Thus, the experimental class achieved both a higher posttest score and a higher mean N-Gain. Although the similar pretest scores support the comparison between groups, they do not fully establish that the groups were equivalent in all respects.

The higher N-Gain in the experimental class may be attributable to the module’s use of thematic maps, spatial visualizations, disaster-related case studies, and spatial analysis activities. These components were intended to help students link disaster mitigation concepts with geographical conditions and spatial relationships. The lessons gave students opportunities to read maps, examine local conditions, and connect disasters to real places. However, because the study measured learning outcomes rather than spatial thinking directly, it cannot be concluded that students’ spatial thinking skills improved. The results indicate improved learning outcomes but not necessarily improved spatial thinking.

6. Statistical Comparison Between the Experimental and Control Classes

The results of Welch’s independent-samples t-test comparing the N-Gain scores of the experimental and control classes are presented in Table 4.



Table 4. Welch's Independent-Samples t-Test for N-Gain Scores

Statistic	Pretest	Posttest	Result
Experimental class, mean N-Gain (SD)			0.8617 (0.0138)
Control class, mean N-Gain (SD)			0.6268 (0.0189)
Experimental class	53.43	93.57	
Control class	53.9	82.81	
Mean difference			0.2349
<i>t</i>			45.95
<i>df</i>			36.59
<i>p</i>			< .001
95% confidence interval of the mean difference			[0.2245, 0.2453]
Cohen's d			14.18
Decision			Significant ($p < .05$)

As shown in [Table 4](#), the analysis indicated a significant difference in N-Gain between the experimental class and the control class, $t(36.59) = 45.95$, $p < .001$. The estimated mean difference was 0.2349, with a 95% confidence interval ranging from 0.2245 to 0.2453. Because the 95% confidence interval does not include zero, the result supports a difference in mean N-Gain between the two classes. The direction of the difference indicates that the experimental class achieved a higher mean N-Gain than the control class.

Taken together, the descriptive N-Gain results and the inferential analysis indicate that the experimental class achieved higher normalized learning gains than the control class in this study. Nevertheless, the quasi-experimental design involved intact classes at a single school. Accordingly, the findings provide evidence of a difference within the participating context but do not establish that the module would produce the same results in other schools or student populations.

The findings are consistent with [Hidayah and Wagistina \(2023\)](#), who reported that spatial-based learning could improve students' disaster spatial literacy through the use of geospatial media and spatial analysis activities. The present study extends this line of research by integrating spatial representations and analysis activities into a structured Geography module designed specifically for Grade XI students. Similarly, [Kusumah et al. \(2024\)](#) found that disaster education incorporating active learning activities contributed positively to students' spatial abilities. These findings underscore the importance of providing learning experiences that require students to actively interpret and analyze geographical information rather than rely solely on textual explanations.

The findings also reinforce the importance of spatial thinking in Geography learning. [Goodchild and Janelle \(2010\)](#) emphasized that spatial literacy enables students to understand relationships among geographical phenomena and develop analytical skills relevant to everyday contexts. In the present study, spatial thinking was embedded in disaster mitigation learning through activities involving map interpretation, identification of disaster-prone areas, analysis of geographical factors, and disaster-related case studies. Such activities provide students with opportunities to connect geographical concepts with real-world disaster risks.

7. Spatial-Based Modules as Enrichment for Geography Learning

The contribution of the developed module lies in integrating spatial representations into disaster mitigation learning. This approach reflects the disciplinary nature of Geography, which examines phenomena in relation to their location, distribution, spatial patterns, and geographical context. In disaster mitigation education, such a perspective is relevant because disaster risks vary according to physical characteristics, settlement patterns, land use, and other conditions of particular areas. The integration of thematic maps, spatial visualizations, contextual disaster cases, and spatial analysis activities was therefore intended to help students connect disaster mitigation concepts with geographical conditions rather than merely memorize factual information.



This approach is consistent with [Ayuningtyas and Irawan \(2024\)](#) and [Lase et al. \(2026\)](#), who reported the contribution of geospatial media to spatial literacy in disaster mitigation learning, and [Sari et al. \(2025\)](#), who emphasized the importance of spatial literacy in interpreting geographical phenomena. The present study extends this line of work by incorporating spatial representations and analysis activities into a structured instructional module for Grade XI students. The higher N-Gain observed in the experimental class provides evidence of greater learning improvement in the participating group. However, because spatial literacy was not measured separately, the findings should not be interpreted as direct evidence that the module improved students' spatial literacy. Rather, they support the potential value of integrating spatially oriented materials into Geography instruction on disaster mitigation.

8. Implications of the Module Development for Geography Learning

The developed module has practical implications for Geography instruction, particularly in disaster mitigation learning at the Grade XI level. It can serve as a supplementary instructional resource by integrating thematic maps, spatial visualizations, contextual cases, and analytical activities into a structured learning sequence. The design principles may also inform the development of materials for other Geography topics involving spatial relationships, such as lithospheric dynamics, atmospheric processes, hydrological phenomena, and rural–urban interactions. However, adaptation to other topics should be guided by their specific learning objectives and content characteristics ([Bearman et al., 2016](#)).

Further research should examine learning outcomes using larger samples and diverse educational contexts. Studies could also assess spatial thinking, critical thinking, problem-solving, or disaster preparedness using instruments specifically designed to measure these constructs. Such investigations would help establish whether spatial-based instructional materials contribute to competencies beyond the learning outcomes examined in the present study.

Building on these results, the following discussion interprets the main findings, situates them within the theoretical basis of spatial-based Geography learning, and outlines their practical implications, limitations, and directions for future research.

a. Interpretation of the Main Findings

The findings provide evidence that the new Geography module can serve as a useful supplementary resource for teaching disaster mitigation to Grade XI students. The module received validation scores of 61% for subject matter, 82% for language, and 77% for media presentation. The teacher response score was 85% and the student response score was 84.28%, indicating that both the teacher and the students responded favorably to the module in the participating setting. These results address two aspects of product evaluation: expert validation concerns the quality of the content and its presentation, whereas questionnaire responses reflect users' perceptions of the module's usefulness.

In terms of learning effectiveness, the experimental class achieved a mean N-Gain of 0.8617, compared with 0.6268 for the control class. The statistical comparison also showed a significant difference in N-Gain between the groups, $t(36.59) = 45.95$, $p < .001$. These results indicate that the experimental class achieved greater normalized learning gains than the control class. However, the effect size is exceptionally large (Cohen's $d = 14.18$) and should be verified against the original student assessment records. Although the data indicate a difference between the two classes, the magnitude and generalizability of this difference should be interpreted with caution.

In short, the Geography module shows promise as a resource for disaster mitigation learning among Grade XI students, and the experimental class in this study achieved greater learning gains than the control class. Nonetheless, given the unusually large effect size, the results should be verified against the original records before broader conclusions are drawn.

b. Theoretical Interpretation and Contribution to Geography Learning

The significance of this approach is closely tied to the nature of Geography as a discipline. Geography examines phenomena in terms of their location, distribution, spatial



arrangement, and interactions across areas (Lukermann, 1964). This perspective is particularly important in disaster mitigation because disaster risk depends on factors such as settlement patterns, land use, and other geographical conditions (Canete, 2025). Materials that incorporate maps and diagrams can therefore help connect disaster mitigation concepts with the geography of particular places.

The developed module includes maps, spatial visualizations, real disaster cases, and spatial analysis activities. These components are intended to help students interpret information, compare places, and understand how disasters relate to their spatial context. In this approach, thematic maps are not merely illustrations but analytical tools for identifying where disasters are more likely to occur and for relating those patterns to geographical conditions (Liu & Wang, 2010). For example, when studying landslides, students can examine slope gradients and rainfall levels; when discussing earthquakes and volcanoes, they can consider Indonesia's tectonic setting. Such examples help students relate classroom learning to real geographical conditions.

This instructional approach aligns with the National Research Council (2006) framework for spatial thinking in education. It is also consistent with research emphasizing the importance of spatial representations and spatial understanding in Geography (Mitchell et al., 2008; Sarafova, 2023). However, the main contribution of this study lies in combining maps, spatial visualizations, and real-life cases into a structured disaster mitigation module for Grade XI students. The higher N-Gain in the experimental class suggests that this approach may help improve learning outcomes. Because the study did not examine each module component separately, it cannot be determined whether the difference resulted from the maps, the activities, or the visualizations. Moreover, spatial thinking and spatial literacy should not be regarded as outcomes of this study because these constructs were not measured directly.

c. Practical Implications, Limitations, and Future Directions

The developed module can serve as an instructional resource for disaster mitigation learning. It combines geographical content, thematic maps, spatial visualizations, contextual examples, and learning activities. The teacher and student responses suggest that the module was perceived favorably in the participating school. Its design may also inform the development of materials for other Geography topics involving spatial relationships, such as lithospheric dynamics, atmospheric processes, hydrological phenomena, and rural-urban interactions. However, adaptation to other topics should be guided by their specific learning objectives and content characteristics rather than by simply replicating the module's structure.

Several limitations should be considered when interpreting the findings. First, the study involved 42 students from two intact classes at a single madrasah, which limits the generalizability of the results to other educational settings. Second, each validation aspect was assessed by only one expert; therefore, inter-rater agreement could not be established. Third, the study examined only learning outcomes and did not directly measure spatial thinking, spatial literacy, or disaster preparedness. In addition, the large standardized effect calculated from the N-Gain data requires verification against the original assessment records before substantive conclusions can be drawn about its magnitude.

Future research should examine the module with larger samples across multiple schools and involve multiple experts for each validation aspect. Further studies should also report evidence of the validity and reliability of the learning outcome instrument. Additional studies could assess spatial reasoning, map interpretation, critical thinking, or disaster preparedness using instruments specifically designed for these constructs. Overall, the findings support the potential of spatially oriented instructional materials as a supplementary resource for disaster mitigation learning in Geography. Nevertheless, broader implementation and further evaluation are needed to establish the robustness of the learning gains and to confirm the module's applicability across educational contexts.



CONCLUSIONS AND SUGGESTIONS

This study developed a spatial-based Geography module to support disaster mitigation learning among Grade XI students. The module integrates thematic maps, spatial visualizations, real-life disaster cases, and spatial analysis activities that help students connect disaster mitigation concepts with specific places and conditions. Expert validation, teacher and student responses, and the comparison of learning gains between the experimental and control classes indicate that the module can serve as a useful supplementary resource for classroom instruction. However, because the results were obtained from a single school, they should be interpreted with caution in light of the study's design limitations. Further research involving more schools and larger samples, as well as direct measures of students' spatial thinking, is needed to determine the module's effectiveness in different settings and its contribution to students' key geographical skills.

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