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Strategic intervention materials-based instruction on disaster literacy for technology students using the ADDIE model

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Disaster literacy among technology students is crucial for effective disaster management, especially in the Philippines, a country prone to natural hazards. This study evaluated the effectiveness of strategic intervention materials (SIM)-based instruction, employing the ADDIE model, in enhancing disaster literacy among technology students. The study used an explanatory sequential research design, integrating an experimental one-group pretest-posttest quantitative analysis with an experiential, phenomenological qualitative approach. Thirty second-year technology students in an environmental science course were recruited using the fishbowl randomization method. The SIM was assessed using a set of criteria, including content, format, presentation, and information accuracy. All five modules exceeded the minimum required standards. Students were engaged in SIM-based instruction, focusing on disaster risk reduction management. Pretest-posttest data revealed statistically significant improvement in student performance on disaster topics, with the overall mean score increasing from 18.97 to 39.50 ($p < 0.001$). Despite weak correlations among the domains, descriptive statistics and correlation analysis showed high student agreement in cognitive, affective, and psychomotor domains, indicating holistic learning gains. Qualitative findings further supported the quantitative results, highlighting that SIM based instruction enhanced student engagement, comprehension, and independent learning. However, some participants noted challenges. These insights emphasize the need for further refinement by incorporating contextual examples and multimodal content to cater to diverse learning preferences. SIM is an effective pedagogical tool for disaster literacy, promoting active engagement, improved academic performance, and preparedness behaviors among students.

KEYWORDS

ADDIE model, disaster literacy, environmental science, explanatory sequential research design, strategic intervention materials

1 Introduction

Climate change has become undeniable, increasing the frequency and intensity of natural disasters such as typhoons, floods, and earthquakes (Dey and Lewis, 2021; Teh and Khan, 2021). These disasters pose significant threats to human lives, infrastructure, and the environment, prompting the need for effective disaster preparedness and response measures

(Salimi and Al-Ghamdi, 2020). The Philippines, as an archipelagic country, is prone to weather-related risks such as tropical cyclones, monsoon rains, and dry spells that have caused dangers (such as landslides and floods) to become disasters (Santos, 2021; Warren, 2020). The Philippines is very vulnerable to extreme weather events such astyphoons, droughts, and heavy rainfall, which have significant impacts on the country's economy and society (Hong et al., 2022; Lagmay and Rodrigo, 2022) For instance, Typhoon Goni in 2020 killed 25 people and destroyed over 280,000 homes, with estimated damages to crops, cattle, fisheries, and agriculture totaling P5 billion, while Typhoon Haiyan in 2013 inflicted damages estimated at US$5.8 billion (Lagmay and Rodrigo, 2022). Despite efforts by the government and various organizations to enhance disaster resilience, there remains a pressing need to strengthen disaster literacy among the population, particularly among technology students who can play a crucial role in disaster risk reduction and management.

Several authors have stressed the importance of integrating disaster risk reduction and management (DRRM) education into the curriculum, especially in educational institutions. Mutch (2023), for example, examines the vital role that schools play in disaster planning, response, and recovery, emphasizing the need to utilize educational initiatives to provide kids the skills and information they need to lessen the effects of disasters. The research emphasizes the importance of incorporating disaster risk reduction into school curricula and promoting a prepared culture to increase community resilience to disasters. Similarly, Kucuksuleymanoglu (2025) and Cabello et al. (2021) emphasized the role of educational institutions in fostering a culture of preparedness and resilience among future generations. Additionally, Orine et al. (2024) and Gabucan and Sanchez (2021) promoted the use of strategic intervention materials (SIM) in environmental education settings to improve disaster literacy and preparedness. The usefulness of the ADDIE (Analysis, Design, Development, Implementation, Evaluation) approach in creating and executing educational resources for disaster preparedness were further highlighted by Syarif et al. (2024), Guo et al. (2025) and Muryani and Ni'matussyahara (2024) also stressed the importance of incorporating real-life scenarios and hands-on activities into disaster education programs to enhance learning outcomes.

Despite the existing literature on disaster education and instructional materials, there remains a notable gap in understanding how disaster literacy can be effectively developed among technology students in the Philippines. Most previous studies have focused on general education populations, community groups, or secondary students, with limited attention given to the distinct learning needs and disciplinary contexts of technology students who are expected to apply technical knowledge in real-world disaster management scenarios. This lack of focused research limits the development of instructional strategies that integrate both technical and disaster preparedness competencies. Moreover, empirical applications of the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model in developing Strategic Intervention Materials (SIM) specifically aimed at enhancing disaster literacy in higher education remain scarce. While the ADDIE model has been widely used in general instructional design, its practical implementation in designing SIM for disaster literacy, especially within technology education—has not been adequately documented in Philippine higher education research. This presents an important opportunity to extend the current knowledge base by exploring how the ADDIE model can guide the systematic development of SIM tailored to the learning context of technology students.

To address these research gaps, the present study developed and implemented SIM based on the ADDIE model to strengthen disaster literacy among technology students in the Philippines. By focusing on this specific academic group and employing a structured instructional design framework, the study contributes new empirical evidence to disaster education and instructional design research.

1.1 Research aim and research question

This study determined the effectiveness of Strategic Intervention Materials (SIM)-based instruction in teaching disaster risk reduction management among technology students using the ADDIE model. Specifically, it identified the level of acceptability of SIM in terms of content, format, presentation and binding, and accuracy and up-to-date information; distribution of the pretest and posttest scores of the students on the topics in Disaster Risk Reduction and Management (DRRM); significant mean difference between the pretest and posttest scores, perceived benefits of SIM in terms of cognitive, affective, and psychomotor; significant relationship between the academic performance and level of perception on the use of SIM; and learning experiences using SIM.

2 Methods

2.1 Research design

A multi-method approach was employed to assess the effectiveness and acceptability of SIM-based instruction on disaster literacy. A descriptive quantitative design evaluated its acceptability, while a one-group pretest-posttest experimental design measured its impact. Researchers administered a pretest, implemented SIM-based instruction, and conducted a posttest to compare students' literacy levels before and after the intervention. For the qualitative component, Braun and Clarke's (2006) thematic analysis was used to analyze data from a focus group discussion (FGD) with five students. This approach identified key themes and patterns in their responses, offering deeper insights into their perceptions. Combining quantitative and qualitative methods ensured a comprehensive evaluation of the intervention's effectiveness.

2.2 Participants

The researchers recruited 30 s-year technology students using the fishbowl randomization method, in four sections. This method involves drawing names from a container, akin to selecting a fish from a bowl, ensuring a randomized selection process, minimizing bias, and ensuring representative sampling across different groups within the student population (Ahmed, 2024). The students came from four sections of the College of Technology in a technological university in the fifth district of Cebu, Philippines. Technology students were chosen as participants in the study because they represent a cohort with a unique aptitude for understanding and applying technological solutions to address contemporary challenges, including disaster management, making them

ideal candidates for evaluating the effectiveness of Strategic Intervention Materials (SIM)-based instruction in enhancing disaster literacy.

2.3 Instrument

Four instruments were used in the study. The degree of acceptance of SIM in terms of content, format, presentation, and binding, as well as correctness and current information, was assessed using an instrument adopted from the Department of Education Evaluation Form of Printed Materials. An expert panel validated a researcher-made pretest and posttest questionnaire based on Bloom's Taxonomy framework, and a reliability test with a Cronbach's alpha score of 0.84 was used to assess SIM's efficacy. The test covered the topics of the concepts and effects of disaster, hydrometeorological hazards, geological hazards, fire hazards, and community-based disaster risk reduction management. To determine the perceived benefits of SIM in terms of cognitive, affective, and psychomotor, an adopted questionnaire from Dandan (2022) was used. A validated interview guide was utilized with questions from experts in instrumentation. The interview guide led the researchers to obtain relevant information to comprehend the technology students' learning experience.

2.4 Data-gathering procedure

The data-gathering procedure for this study followed a structured approach aligned with the ADDIE Model. Initially, the analysis phase involved a needs assessment to determine existing gaps in disaster literacy among technology students. This was conducted through pre-test assessments designed to establish their baseline knowledge. In the design phase, Strategic Intervention Materials (SIM) were developed based on the identified learning needs, ensuring close alignment with core disaster preparedness concepts. Figure 1 presents the developed SIM's front page, which covers five key disaster literacy topics relevant to the learners' context.

During the development phase, the SIMs underwent expert validation by specialists in education and disaster management to ensure content accuracy, contextual appropriateness, and pedagogical soundness. The implementation phase involved classroom-based sessions using SIM-integrated instruction, where students actively engaged with the materials through guided learning and independent tasks. Data were collected through a combination of direct observation, student performance tracking, and learner feedback during the intervention. Finally, the evaluation phase assessed the effectiveness of the SIMs using multiple data sources, including pre-test and post-test scores, student surveys, and semi-structured interviews. Comparisons of these data sets determined the materials' impact on students' disaster literacy and their preparedness competencies. Additional feedback from both students and teachers informed the refinement of the materials for future instructional use.

Ethical considerations were carefully integrated throughout all stages of the research process. Prior to data collection, informed consent was obtained from all participants after they were fully briefed on the purpose, procedures, and voluntary nature of their participation. They were assured that participation was entirely voluntary, and they could withdraw from the study at any time without penalty. Confidentiality and anonymity were strictly maintained by coding responses and ensuring that no identifying information appeared in the research outputs. The study adhered to the provisions of the Philippine Data Privacy Act of 2012 (Republic Act No. 10173) and the institution's research ethics guidelines, ensuring compliance with national standards on data protection. Although the study did not require formal ethics board approval, the researcher implemented all necessary ethical safeguards to uphold participant welfare, respect for privacy, and the responsible handling of all collected data.

2.5 Data analysis

A t-test for correlated samples was employed to determine whether the pretest and posttest performances differed significantly. This was employed to test the hypothesis that no significant difference exists between before and after the program. The test was conducted at a level of significance, $\alpha = 0.05$. Mean and standard deviation were utilized to determine SIM's level of acceptability in content, format, presentation, binding, accuracy, and up-to-date information, and the level of perceived benefits of SIM in cognitive, affective, and psychomotor domains. Pearson's correlation was used to determine the significant relationship between academic performance and the level of perception of using SIM.

For qualitative data, the researchers used the thematic analysis by Braun and Clarke (2006) to capture the participants' learning experiences. Narratives from the participants were translated into English, and the distinct categories in the data that answered the

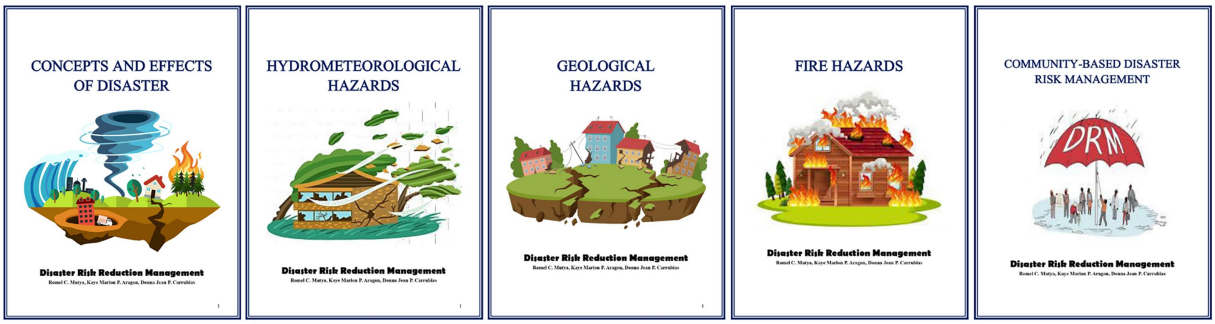

FIGURE 1
Cover Page of the Developed SIMs.

research questions were identified. Additionally, the researchers created the first codes by narrowing down the broad categories to create subcategories. The codes were created using the phrases that emerged from the participants' comments while keeping them close to the original transcripts. After that, the researchers reread the transcripts, checked themes, and offered feedback on their accuracy. The researchers devised the names for each theme and created the descriptions of the themes. Lastly, the researchers selected relevant quotes to illustrate the themes from the participants' answers. Three researchers conducted all these procedures, and the third verified their accuracy and consistency. These were carried out in several sessions to foster credibility. Through member verification, the researchers carried out validation and assessment to improve the study's rigor (Birt et al., 2016). The interview transcript and data analysis were provided to the participants to confirm their accurate responses. After discussing the contents of the response transcript and reading it to them again, the participants and researchers agreed. Figure 2 illustrates the entire process for analyzing the qualitative data.

3 Results

3.1 Evaluation of SIM on disaster literacy

The evaluation of the strategic intervention materials (SIM) on disaster literacy, as shown in Table 1, reveals a strong adherence to the standards. All evaluated modules (M1-M5) surpassed the minimum required points across four key criteria: content, format, presentation, accuracy, and up-to-datedness of information. The average content score was 26.20, within the acceptable range of 1–28, indicating that the learning materials effectively address essential disaster-related concepts. Similarly, the average format score was 68.20, reflecting a clear structure, visual appeal, and learner-friendly organization elements identified by Mallillin et al. (2025) as crucial in effective instructional design. Moreover, the strong presentation and information accuracy scores (18.40 and 23.00, respectively) affirm the materials' clarity, relevance, and current alignment with disaster preparedness standards (Fauza et al., 2021; Ridha et al., 2019).

3.2 Distribution of the pretest and posttest scores of the students

The data in Table 2 presents a marked improvement in students' performance after exposure to the SIM on disaster literacy. Each topic showed a significant increase in mean scores from pretest to posttest, with an overall mean of 18.97 to 39.50, a paired difference of 20.53. The consistently low p-values (0.000) and high negative t-values confirm that the gains are statistically significant, validating the effectiveness of SIM in enhancing students' understanding of disaster-related concepts. Recent studies have underscored the increasing relevance of contextualized and technology-integrated disaster education. For instance, Agustin and Gurat (2024) demonstrated that contextualized DRRM modules significantly improve learners' preparedness and engagement, aligning with learner-centered approaches in disaster risk education. Similarly, Orine et al. (2024) emphasized the use of Strategic Intervention Materials (SIM) as

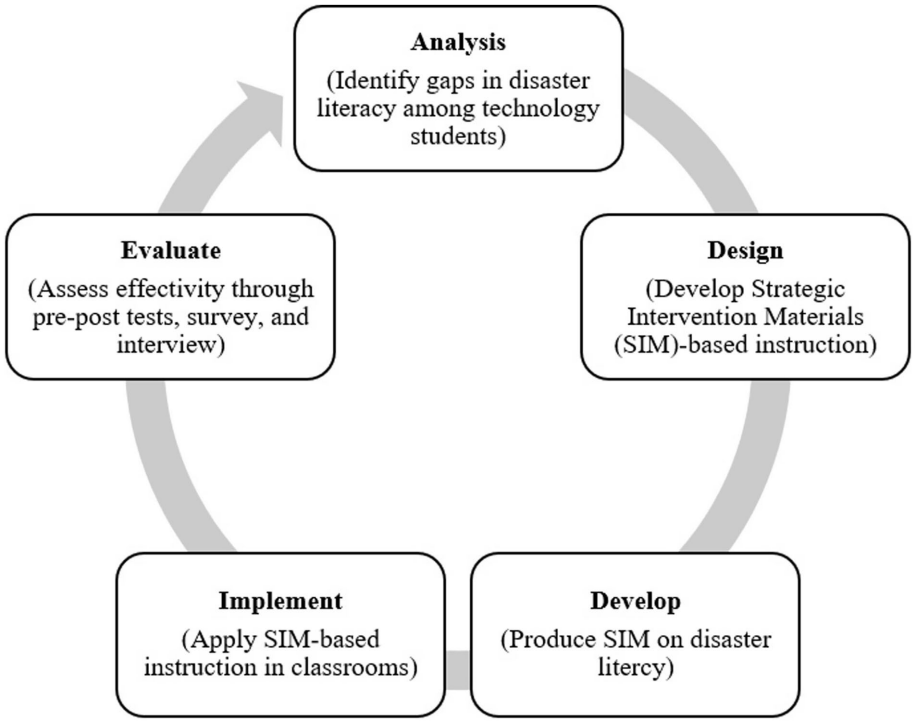

FIGURE 2
ADDIE Model of Instructional Module.

TABLE 1 Evaluator's summary of points of SIM on disaster literacy.

Criteria	Point to Pass (DepEd, 2018)	Mean Scores of Evaluators					Average score (M1-M5)
		M1	M2	M3	M4	M5	
Content	At least 21 to 28	26	28	25	27	25	26.20
Format	At least 54 to 72	70	68	65	71	67	68.20
Presentation	At least 15 to 20	18	18	20	17	19	18.40
Accuracy and up-to-datedness of information	At least 20 to 24	23	22	23	23	24	23.00

M, Module.

TABLE 2 Students' pretest and posttest performance levels.

Topics	Pretest	Posttest	Mean paired difference	*t*-value	*p*-value	Interpretation
Concept and effects of disaster	4.30	7.67	3.37	−14.49	0.000	Significant
Hydrometeorological hazards	4.10	7.60	3.50	−12.66	0.000	Significant
Geological hazards	3.87	8.03	4.16	−16.70	0.000	Significant
Fire Hazards	3.40	8.30	4.90	−23.23	0.000	Significant
Community-based DRRM	3.30	7.90	4.60	−20.18	0.000	Significant
Overall	18.97	39.50	20.53	−33.17	0.000	Significant

$p < 0.05$ is significant.

effective, flexible tools for science and environmental learning, promoting both conceptual understanding and preparedness. Moreover, Aroyandini and Rusilowati (2025) highlighted how the elaboration of disaster knowledge enhances the practical implementation of disaster education, reinforcing the importance of structured instructional models such as ADDIE in developing resilience-oriented educational materials.

3.3 Perceived benefits of using SIM-based instruction

Table 3 presents descriptive statistics and Pearson correlation analysis among the cognitive, affective, and psychomotor learning domains, with all three constructs receiving mean scores above 4.20, falling within the "Strongly Agree" category. This indicates that students highly recognized the SIM on disaster as intellectually enriching (cognitive mean = 4.233), emotionally engaging (affective mean = 4.246), and behaviorally actionable (psychomotor mean = 4.260). These results affirm the materials' effectiveness in promoting holistic learning, essential in disaster education, where knowledge, attention, and action must work in collaboration (Aroyandini and Rusilowati, 2025; Masocha et al., 2025). However, the correlation values show weak relationships among the domains: cognitive-affective (−0.033), cognitive-psychomotor (0.128), and affective-psychomotor (0.020), suggesting limited interdependence among technology students' perceptions in these areas. This supports the view of Kou et al. (2024), who emphasized that multidimensional learning outcomes do not continually develop simultaneously and may require targeted pedagogical strategies.

3.4 Learning experiences using strategic intervention materials (SIM)

This section presents the positive and negative learning experiences of participants who utilized with Strategic Intervention Materials (SIM) on topics on disaster literacy.

3.4.1 Positive experiences

3.4.1.1 Theme 1: engagement and interest

3.4.1.1.1 Subtheme 1.1: learning is fun and engaging.

Many participants expressed that SIM-based instruction transformed their learning experience into something enjoyable and stimulating. The interactive activities and engaging tasks made the lessons more exciting and motivating. As one participant shared, *"Learning through SIMs is enjoyable because the activities are interactive and engaging" (P3)*. This sentiment reflects how SIMs capture learners' attention and make them active participants in the learning process, rather than passive recipients of information.

3.4.1.1.2 Subtheme 1.2: encourages independent learning. Participants also highlighted how SIM-based instruction promotes autonomy and self-directed learning. Through SIMs, students can study at their own pace, which fosters accountability and ownership of their learning journey. As one participant remarked, *"I appreciate how SIMs allow me to study at my own pace, making me feel more responsible for my learning" (P2)*. This demonstrates that SIMs not only enhance engagement but also empowers learners to become more self-reliant and reflective in their studies.

TABLE 3 Descriptive statistics and Pearson correlation analysis among cognitive, affective, and psychomotor.

Construct	Mean*	SD	Cognitive	Affective	Psychomotor
Cognitive	4.233	0.423	1.000		
Affective	4.246	0.409	−0.033	1.000	
Psychomotor	4.260	0.495	0.128	0.020	1.000

1.00–1.79 (Strongly Disagree); 1.80–2.59 (Disagree); 2.60–3.39 (Neutral); 3.40–4.19 (Agree); 4.20–5.00 (Strongly Agree).

3.4.1.2 Theme: 2: learning effectiveness

3.4.1.2.1 Subtheme 2.1: Improves Understanding and Retention.

Learners consistently mentioned that the structured format of SIMs helped them comprehend lessons better and retain information longer. The clarity and logical progression of concepts made learning more meaningful. Participants stated, "*The structured approach of SIMs helps me remember lessons better and makes learning more meaningful*" *(P3).* This suggests that the SIM framework contributes to deeper understanding by reinforcing key ideas in an organized manner.

3.4.1.2.2 Subtheme 2.2: makes complex topics easier to understand. Students also emphasized that SIMs simplify challenging topics by breaking them down into manageable parts. As one learner shared, "*Difficult concepts become clearer because of the step-by-step explanations*" *(P5).* This indicates that SIM-based instruction supports cognitive processing by presenting content in a way that reduces learning anxiety and promotes conceptual clarity.

3.4.1.3 Theme 3: content presentation

3.4.1.3.1 Subtheme 3.1: well-structured and easy to follow.

Participants commended the logical and user-friendly structure of SIMs, which made navigation and comprehension more straightforward. "*The SIMs are arranged in a way that makes it simple to navigate and understand*" *(P4)* expressed the learners' appreciation for the clear organization and layout of the materials. This structural coherence ensures that learners can easily track their progress and focus on content mastery.

3.4.1.3.2 Subtheme 3.2: clear instructions and explanations. Clarity of instructions was another strength identified by participants. Concise explanations and guided steps made the learning process smooth and less confusing. As one respondent noted, "*I like how the SIMs provide concise and well-explained steps, making learning smooth*" *(P1).* This implies that the design of SIM-based materials supports learner comprehension and minimizes ambiguity in task execution.

Overall, participants' narratives illustrate that SIM-based instruction provides an interactive and structured approach that enhances student engagement, comprehension, and retention. Learners find the experience enjoyable and empowering, as SIMs allow them to take control of their learning pace while simplifying complex concepts. The clarity and organization of content presentation further contribute to effective learning experiences, validating SIMs as a valuable instructional tool in promoting active, independent, and meaningful learning.

3.4.2 Negative experiences

3.4.2.1 Theme 4: challenges in learning

3.4.2.1.1 Subtheme 1.1: some topics need more elaboration.

Despite the overall effectiveness of SIM-based instruction, several participants expressed that some lessons lacked sufficient explanation. This lack of depth made it difficult for them to fully grasp certain concepts. As one participant pointed out, "*Some lessons feel a bit lacking in explanation, which makes it difficult to grasp certain concepts.*" *(P1).* This indicates a gap in content elaboration that may hinder learner comprehension, especially when dealing with abstract or complex topics. The observation resonates with the findings of Jung et al. (2022) and Balahadia et al. (2025), who emphasized that clarity and depth of explanation are essential for effective learning in self-paced materials.

3.4.2.1.2 Subtheme 1.2: requires additional examples for better understanding. Participants also highlighted the need for more real-life examples to make the lessons more relatable and easier to understand. One participant remarked, "*The content would be easier to comprehend if more real-life examples were provided.*" *(P4).* This feedback reflects the learners' desire for contextual learning—where abstract concepts are linked to real-world situations to enhance relevance and retention. This aligns with Indriati et al. (2024), who emphasized that integrating authentic examples into learning materials strengthens conceptual understanding and fosters deeper engagement.

3.4.2.2 Theme 5: technical difficulties

3.4.2.2.1 Subtheme 2.1: too much text can be overwhelming.

A few participants noted that excessive text within the SIMs made it challenging to sustain focus and absorb the information effectively. As expressed by one respondent, "*Sometimes, there is much reading involved, making it hard to focus and absorb the information.*" *(P2).* This suggests that text-heavy content can contribute to cognitive overload, reducing learner motivation and attention span. Concise and visually supported content may therefore be more effective for sustaining engagement and facilitating comprehension.

The qualitative responses reveal that while SIM-based instruction was generally effective in promoting engagement and understanding, learners also faced specific challenges that affected their learning experience. The need for more detailed explanations and contextual examples underscores the importance of scaffolding content for better comprehension. Additionally, the overwhelming amount of text points to the necessity of balancing information density with visual and interactive elements to sustain learner focus. These findings suggest that although SIM was pedagogically sound and beneficial, its effectiveness could be further enhanced by integrating more elaborate,

contextual, and multimodal learning features. This approach would not only improve conceptual clarity but also ensure that learners remain actively engaged throughout the self-instructional process.

4 Discussion

The main goal of the study was to develop and implement a Strategic Intervention Material (SIM) using the ADDIE model to build disaster literacy among technology students in the Philippines. The study's findings underscore the SIM's effectiveness and potential as a valuable educational tool for enhancing disaster literacy among students, especially in the Philippines, which is highly vulnerable to natural hazards. Recent studies emphasize the importance of accessible and well-structured instructional materials in promoting student preparedness and risk reduction behaviors (Pant, 2024; Tasantab et al., 2023). Consistent evaluator ratings across all modules suggest a well-developed material that supports independent learning and reinforces critical thinking during disaster situations. The efficacy of the SIM was evident in the significant improvement in students' posttest performances, highlighting the value of integrating localized and structured disaster education into the curriculum. Quantitative improvements align with the findings of Mubarak et al. (2019) and Nakano and Yamori (2021), who reported similar gains in student awareness and preparedness in disaster education programs. These results affirm that targeted instructional interventions can foster proactive safety behaviors and build resilience, particularly in disaster-prone areas. The SIM not only enhanced academic knowledge but also likely contributed to behavioral change, supporting the continued development of instructional materials that align with university's goals on disaster preparedness.

Despite weak correlations across learning domains, the consistently high mean values reflect the SIM's overall positive reception and perceived impact. The slightly higher psychomotor mean suggests that students not only understand disaster concepts but are also likely to apply them in real-life scenario, an essential outcome in disaster risk reduction education (Bai et al., 2024; Lu et al., 2022). The weak inter-domain correlations were interpreted through the multidimensional learning model proposed by Sönmez (2017) and Kou et al. (2024), which emphasizes that learning domains, cognitive, affective, and psychomotor, may operate semi-independently yet interact dynamically. This suggests that while students were engaged across domains, each may have been influenced by different instructional components or personal experiences. Hence, future iterations of the SIM should integrate more reflective (affective) and skill-based (psychomotor) activities to strengthen conceptual (cognitive) understanding and foster deeper domain integration.

Complementing the quantitative findings, qualitative insights from participants indicate that SIM-based instruction improved comprehension and retention, particularly by breaking down complex topics into manageable and understandable components. The structured and organized nature of the SIM guided students through lessons at their own pace, enhancing engagement and autonomy. However, participants also noted the need for clearer explanations and more real-life examples to further contextualize learning. These qualitative themes, engagement, comprehension, and contextual learning are consistent with the findings of Limbago-Bastida and Bastida (2022), and Bacatan et al. (2022), who highlighted that SIM promotes active, reflective, and independent learning by providing focused content that bridges conceptual gaps.

Overall, the integration of both quantitative and qualitative results provides a comprehensive understanding of the SIM's educational impact. While it effectively enhanced disaster literacy and engagement, continuous refinement is necessary to ensure alignment with diverse learning styles and contexts. These findings contribute to the growing body of literature supporting structured and contextualized instructional designs as powerful tools for building disaster resilience and adaptive learning in the Philippine education system.

5 Conclusion

This study affirmed the effectiveness of SIM-based instruction in enhancing disaster literacy among technology students. The notable improvements observed in disaster literacy indicators-supported by both quantitative pretest-posttest data and qualitative student feedback-highlight the transformative potential of SIMs in education. These findings reinforce the study's central objective that SIM-based instruction serves as a powerful pedagogical tool in preparing students to respond proactively to disasters. By equipping technology students with critical knowledge and practical skills, the SIM-based instruction not only enhances academic outcomes but also fosters a culture of preparedness and resilience. Its integration into technology education curricula is not merely beneficial-it is imperative for building future-ready professionals who can contribute meaningfully to disaster risk reduction and community safety.

To sustain and expand these gains, technology education institutions and curriculum developers are encouraged to institutionalize SIM-based instruction as one of the core strategies for disaster literacy. Moreover, ongoing refinement of SIMs is essential to ensure responsiveness to emerging risks and diverse learning needs of students. Collaboration among educators, policymakers, industry leaders, and disaster management agencies will be vital in scaling up the design, deployment, and impact of SIM-based materials. Ultimately, the study leaves a clear message, and that is to empower students through innovative and targeted instruction, equipping them not only for academic success but also for leadership in safeguarding lives and communities in the face of disaster.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The authors state that the study does not involve sensitive personal data, medical procedures, or vulnerable populations, and poses no more than minimal risk to participants. The study was approved by the campus director of Cebu Technological

University-Danao Campus. All activities are aligned with regular educational practices, and participation is voluntary, with informed consent obtained as appropriate and strictly adhere to the provisions of Philippine Republic Act 10173, also known as the Data Privacy Act of 2012, ensuring that any information gathered is treated with the utmost confidentiality, with data collected, stored, and used solely for academic purposes in a secure and ethical manner. The participants provided their written informed consent to participate in this study.

Author contributions

RM: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. RT: Conceptualization, Formal analysis, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. KA: Methodology, Project administration, Resources, Writing – review & editing. DT: Conceptualization, Data curation, Formal analysis, Project administration, Writing – review & editing. AB: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing.

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