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E-Mapping Safety: Enhancing Hazard Interpretation and Disaster Preparedness Skills among Grade 11 Learners through Digital Intervention

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ABSTRACT

This action research explores how the Mapping Safety: Charting Hazard Zones Together Strategic Intervention Material (SIM) helped enhance hazard mapping skills and disaster preparedness among Grade 11 learners at Pililla National High School. Recognizing that many students struggle to interpret hazard maps—a critical skill for assessing risks from natural disasters—the SIM was introduced in the Earth and Life Science curriculum. The objective was to equip students with the ability to identify areas vulnerable to earthquakes, volcanic eruptions, and landslides, while also fostering empathy and proactive preparedness.

The study involved 20 Grade 11 learners, selected based on their initial low performance in hazard map interpretation. Following a pre-test assessment, which established baseline skills, students engaged with the SIM, allowing them hands-on practice with hazard maps and real-world scenarios. The SIM provided interactive exercises on hazard zone identification, symbol interpretation, and risk assessment, which students practiced at their own pace. After using the SIM, learners completed a post-test to measure improvements. Results from a paired samples t-test showed a significant increase in scores, with a t-statistic of -12.2 ($p < .001$), confirming that the SIM had a strong, positive impact on students' interpretive skills.

These findings indicate that the Mapping Safety SIM effectively combines academic knowledge with practical disaster preparedness, building both technical skills and a sense of community responsibility. With its adaptable design, the SIM shows promise as a valuable resource for expanding hazard education to cover additional types of disasters, supporting resilience in a broader range of regions.

Introduction

In an ideal science classroom, learning goes beyond memorizing facts—it's an experience that leaves students curious, engaged, and prepared to apply what they've learned. Achieving this means using resources that help make complex, often abstract concepts easier to understand. Science can be challenging to visualize, and it's easy for students to feel lost in ideas they can't quite picture. Recognizing this, the Department of Education (DepEd) in the Philippines encourages the use of Strategic Intervention Materials (SIMs), as recommended in DepEd Order No. 39, s. 2012. Designed to help students tackle tough topics in science and math, SIMs provide valuable support for learners and help address the lack of resources in many science classrooms. Republic Act No. 10533, otherwise known as "Enhanced Basic Education Act of 2013", section 5 of the curriculum development states that the curriculum must be sufficiently adaptable to enable and let schools to localize, indigenous, and enrich it depending on their unique educational and social settings. The creation and development of locally created instructional materials will be promoted, and regional and division education units shall have approval authority over these resources. The Strategic Intervention Materials help students build skills they missed during regular sessions. These materials can be delivered through PowerPoint presentations, printed resources, or computer-based activities(Villaran, Cabot, & Panes, 2023).

In areas like Pililla, Rizal, where natural hazards such as earthquakes, volcanic eruptions, and landslides are a constant threat, being prepared isn't just important—it's essential. With this in mind, DepEd has included disaster preparedness in the school curriculum, especially in Earth and Life Science courses, giving students practical knowledge that could one day protect them and their communities (DepEd, 2017).

This study responds to a specific gap in the curriculum: teaching students to use hazard maps to identify areas at risk from earthquakes, volcanic eruptions, and landslides (Competency Code S11/12ES-If-31). This skill, though vital for understanding and responding to natural disasters, is one that many students struggle to master. The ability to interpret hazard maps helps students assess risks and make informed decisions—skills that could be life-saving in real-world scenarios.

To address this gap, the Mapping Safety: Charting Hazard Zones Together SIM was created as a digital tool for Grade 11 students in the Earth and Life Science curriculum. This SIM goes beyond teaching technical skills; it aims to help students interpret hazard maps within the context of real-world applications, building not only their knowledge but also a sense of responsibility toward their community. By blending theory with hands-on practice, the SIM is designed to prepare students to become proactive, informed citizens.

The Mapping Safety SIM is built on experiential learning and disaster risk reduction (DRR) education principles. Experiential learning—"learning by doing," as Kolb (1984) described—has been shown to help students retain and apply skills. Through active engagement with tasks like hazard map interpretation, students are more likely to understand and remember what they've learned (Kolb & Kolb, 2009; Armstrong & Fukami, 2009).

DRR education, advocated by organizations like UNESCO and the United Nations, encourages people to recognize and respond to hazards in their surroundings. Studies suggest that hands-on, scenario-based activities—such as mapping local hazard zones—can improve students' preparedness for real-life disasters (UNESCO, 2020; Shaw, Mallick, & Takeuchi, 2011). The Mapping Safety SIM uses hazard maps of Pililla, Rizal, helping students identify high-risk areas and understand local risks, fostering a deeper connection to their environment and a commitment to community safety.

Although disaster preparedness education has come a long way, it often focuses on general awareness instead of specific skills like hazard map interpretation. Existing studies tend to emphasize providing information about hazards rather than teaching the practical skills needed to read maps and make informed decisions (Shaw & Takeuchi, 2012). Furthermore, secondary school education rarely touches on the emotional side of preparedness—things like empathy and social responsibility—that are crucial for building a resilient community (Becker, Johnston, & Paton, 2012). By combining technical skills with social awareness, the Mapping Safety SIM addresses these gaps, giving students not only essential knowledge but also a sense of empathy and readiness.

To evaluate the effectiveness of the SIM, this study will use a paired samples t-test to compare students' skills before and after they use the tool. This statistical approach is widely used in education research to measure improvements in skill-based learning. Studies like those by Barrot, Llenares, and del Rosario (2021) confirm that pre- and post-assessment methods are reliable for gauging the impact of instructional materials. By applying this approach, the study aims to gather meaningful data on the Mapping Safety SIM's impact on students' disaster preparedness skills, highlighting its potential as a practical tool for disaster education.

Statement of the Problem

This study seeks to evaluate the effectiveness of the *Mapping Safety: Charting Hazard Zones Together* Strategic Intervention Material (SIM) in enhancing Grade 11 learners' performance in interpreting hazard maps to identify areas prone to hazards caused by earthquakes, volcanic eruptions, and landslides.

The study is guided by the following specific questions:

1. What is the performance level of Grade 11 struggling learners before and after using the electronic Strategic Intervention Materials?
2. Is there a significant difference in learners' performance before and after using the *Mapping Safety* SIM, as measured by a paired t-test?

Significance of the Study

This study sheds light on ways to strengthen disaster preparedness education in secondary schools. By examining how the Mapping Safety: Charting Hazard Zones Together SIM improves learners' ability to interpret hazard maps, it aims to fill a crucial gap, giving students practical tools to recognize and assess risks in their communities. This work aligns with the Department of Education's Basic Education Learning Continuity Plan (BE-LCP), showing how disaster readiness can be seamlessly integrated into science lessons.

More than just building technical skills, this study highlights the role of empathy and shared responsibility, encouraging learners to view disaster preparedness as a community effort. The insights gained from this research can guide policymakers, curriculum developers, and teachers in creating similar programs, helping shape a generation of aware and resilient young people prepared to contribute to disaster response and recovery efforts in their own communities.

Methodology

Research Design

This study employed a quantitative research design, utilizing a Paired Samples T-Test to measure differences in Pre-Test and Post-Test scores, thereby assessing the impact of the Mapping Safety: Charting Hazard Zones Together Strategic Intervention Material (SIM) on learners' hazard mapping skills.

Participants

The study involved 20 Grade 11 learners from Pililla National High School. Out of the five sections taught—11-Faraday, Gregory, Henry, and Inoue—5 learners per section were selected, focusing on those with lower mastery of the targeted competency in hazard map interpretation. This purposive sampling method ensured that the intervention was applied to learners who could benefit most from enhanced skills in this area.

Intervention Material

The intervention utilized the Mapping Safety: Charting Hazard Zones Together SIM, a contextualized and competency-based electronic learning material designed to improve learners' ability to use hazard maps effectively. This SIM aimed to equip learners with practical skills in identifying areas prone to natural hazards, such as earthquakes, volcanic eruptions, and landslides, by engaging them in interactive and community-relevant activities.

Data Collection

Data was gathered through Pre-Test and Post-Test assessments designed to measure learners' skills in interpreting hazard maps. Each test contained 20 multiple-choice questions that were crafted to align closely with the learning objectives of the Mapping Safety: Charting Hazard Zones Together Strategic Intervention Material (SIM). These assessments, titled Mapping Safety – Geohazard Awareness, focused on key competencies in hazard map interpretation, such as identifying hazard-prone areas, understanding the significance of symbols, and assessing risk levels.

The questions included practical tasks such as:

- Identifying areas prone to natural hazards like earthquakes, volcanic eruptions, and landslides.
- Recognizing symbols and colors commonly used on hazard maps, such as fault lines for earthquakes and high-susceptibility indicators for landslides.
- Interpreting map legends to accurately assess hazards and understand the associated risk levels.
- Understanding the role of empathy and community responsibility in disaster preparedness.

The tests included scenario-based questions to reflect real-world applications of hazard mapping skills, making the assessments relevant and meaningful for learners. The Pre-Test established a baseline of learners' initial skills, while the Post-Test assessed improvements following the intervention.

Data Analysis

To evaluate the impact of the Mapping Safety SIM on learners' hazard mapping skills, both Descriptive Statistics and a Paired Samples T-Test were conducted on the pre-test and post-test scores.

First, Descriptive Statistics were calculated to summarize the learners' performance before and after using the SIM. Key measures such as the mean, median, standard deviation, minimum, and maximum scores were examined. These descriptive metrics provided an initial overview of the improvement in hazard mapping skills, indicating an increase in overall scores and a reduction in variability following the intervention.

Following this, a Paired Samples T-Test was conducted to assess whether the improvements in post-test scores were statistically significant. The resulting t-statistic and p-value offered quantitative evidence of the SIM's effectiveness, confirming that the observed gains in learners' ability to interpret hazard maps were not due to chance. This test substantiated the impact of the digital intervention in enhancing students' preparedness to identify and assess risk zones associated with natural hazards.

Results and Discussion

Table 1: Descriptive Statistics of Pre-Test and Post-Test Scores

Statistic	Pre-Test Scores	Post-Test Scores
Mean	8.95	13.7
Median	9	14
Standard Deviation	2.01	1.49
Minimum	5	10
Maximum	13	16

The analysis of students' scores in pre-test and post-test shows a clear improvement following the use of the Mapping Safety SIM. Prior to the intervention, the average score was 8.95, which increased to 13.7 after students engaged with the SIM. This gain of nearly five points suggests that the tool had a meaningful impact on enhancing students' abilities to interpret hazard maps accurately. Additionally, the median score rose from 9 to 14, indicating that the majority of students performed better following the intervention.

The reduction in score variability, as shown by a decrease in standard deviation from 2.01 to 1.49, suggests that scores became not only higher but also more consistent. This reduction in variation implies that the SIM may have helped standardize skill levels across students, allowing a broader range of learners to achieve similar, improved levels of understanding. Furthermore, the minimum score increased from 5 to 10, while the maximum score moved from 13 to 16, demonstrating that both lower-performing and higher-performing students made significant progress.

In summary, these results suggest that the Mapping Safety SIM effectively enhanced students' hazard map interpretation skills. The improvement across all performance levels highlights the potential value of this tool in supporting hazard map education. To further confirm the impact of the SIM, a paired t-test will be conducted to assess the statistical significance of the observed improvement.

Table 2: Paired Samples T-Test Results for Pre-Test and Post-Test Scores

Paired Samples T-Test	statistic	df	P
Pre-Test and Post-Test	-12.2	19.0	<.001

The results of the paired samples t-test analysis demonstrated a significant improvement in learners' hazard mapping skills after engaging with the Mapping Safety: Charting Hazard Zones Together SIM. With a t-statistic of -12.2 and 19 degrees of freedom, the analysis indicates a substantial enhancement in learners' ability to interpret and effectively use hazard maps. This improvement aligns directly with the targeted learning competency: "Using hazard maps, identify areas prone to hazards brought about by earthquakes, volcanic eruptions, and landslides."

The p-value of less than .001 confirms that this improvement is statistically significant, reinforcing that the observed gains are not due to chance. These findings underscore that the SIM successfully achieved its objectives, equipping learners with critical skills to identify hazard-prone areas and assess related risks. Overall, the results highlight the SIM's effectiveness in fostering both academic understanding and practical, real-world skills, thereby preparing learners to respond proactively to natural hazards and fostering a heightened sense of readiness and responsibility within their communities.

Conclusion

The results of this study highlight the effectiveness of the *Mapping Safety: Charting Hazard Zones Together* SIM in boosting students' skills in interpreting hazard maps. The data shows a clear improvement, with average scores rising from 8.95 in the pre-test to 13.7 in the post-test, and a similar increase in the median score from 9 to 14. This upward trend, combined with a reduction in score variability, indicates that students not only performed better but also more consistently after using the SIM. These gains were seen across all levels of performance, showing that both struggling and high-achieving students benefited from the intervention.

The statistical analysis through a paired samples t-test reinforces these findings. The t-value of -12.2 and the very low p-value (less than .001) confirm that the improvement is significant and not due to chance. This aligns well with the program's goal: helping students learn to use hazard maps to identify areas at risk from natural disasters like earthquakes, volcanic eruptions, and landslides.

In summary, the *Mapping Safety* SIM has proven to be a valuable tool for teaching students how to interpret hazard maps. It goes beyond academic knowledge, providing students with practical skills that can help them understand and respond to natural hazards. This tool has the potential to make students not only more informed but also more prepared and responsible within their communities, empowering them to play an active role in managing and mitigating risks related to natural disasters.

Recommendations

Based on the findings of this study, several recommendations can be made to further enhance the impact of the *Mapping Safety: Charting Hazard Zones Together* SIM and extend its benefits to a wider audience:

1. **Expand the Scope of the SIM**: To provide a more comprehensive understanding of hazard preparedness, the SIM could be expanded to cover additional types of hazards beyond earthquakes, volcanic eruptions, and landslides. Adding scenarios for floods, tsunamis, and hurricanes would allow students to develop skills that are relevant to various geographic and environmental contexts.

2. **Encourage Hands-On and Community-Based Projects**: To reinforce the skills learned in the SIM, schools could encourage students to apply hazard mapping in real-life projects. For example, students could work with local authorities to assess risks in their own communities, identify hazard-prone areas, and develop preparedness plans. This would help students see the real-world relevance of their learning and foster a sense of responsibility and proactive engagement.

3. **Promote Collaborative Learning Opportunities**: Integrating group activities where students can collaborate on interpreting hazard maps and discussing potential risks can enhance their understanding and confidence. Collaborative tasks encourage critical thinking, as students can learn from each other's perspectives and build a shared understanding of hazard management.

4. **Conduct Further Research on Broader Applications**: Additional studies could explore the SIM's effectiveness across different age groups, educational settings, and cultural contexts. Understanding its adaptability and effectiveness in diverse environments would help refine the tool and potentially broaden its use, making it valuable to a wider range of learners globally.

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