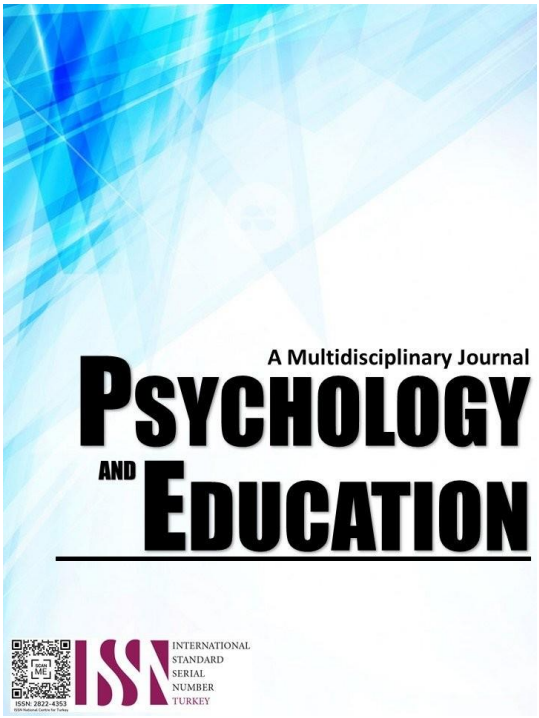
IMPROVING MASTERY LEVEL IN UNDERSTANDING TYPHOON AND EARTHQUAKE PREPAREDNESS THROUGH STEM MODULES



PSYCHOLOGY AND EDUCATION: A MULTIDISCIPLINARY JOURNAL

Volume: 17
Issue 4
Pages: 382-392
Document ID: 2024PEMJ1571
DOI: 10.5281/zenodo.10743472
Manuscript Accepted: 01-31-2024

Psych Educ, 2024, **17**(4): 382-392, Document ID:2024PEMJ1571, doi:10.5281/zenodo.10743472, ISSN 2822-4353

Research Article

Improving Mastery Level in Understanding Typhoon and Earthquake Preparedness Through STEM Modules

Ruem P. Tubo,* Monera Salic- Hairulla, Edna B. Nabua, Elesar V. Malicoban
For affiliations and correspondence, see the last page.

Abstract

In response to the COVID-19 pandemic's impact on education, this study addresses the challenges faced by Filipino educators in delivering quality STEM education and fostering disaster preparedness through modular distance learning. The research aimed to improve Grade 8 learners' mastery level of understanding typhoon and earthquake preparedness through STEM modules using the seven-stage context-based STEM teaching approach as a format. The study used a one-group pretest-posttest design with qualitative support. Based on the results, there is a significant shift from an AVERAGE to MOVING TOWARDS MASTERY LEVEL in learners' understanding of typhoon and earthquake preparedness. The evaluation of emergency preparedness plans and kits underscored the effectiveness of the STEM modules in promoting disaster preparedness. Qualitative insights revealed the benefits and the challenges faced of the participants in using the STEM modules. Furthermore, this study recommends the implementation of STEM modules to a large-scale respondent to cross-validate the findings.

Keywords: *disaster preparedness, education in COVID-19 pandemic, modular distance learning, STEM education, STEM modules*

Introduction

Disasters frequently strike communities that are vulnerable and ill-prepared to cope with natural hazards (Valenzuela et al.,2020). Individuals who have experienced natural disasters firsthand tend to be more proactive in disaster preparedness compared to those residing in low-risk areas (Bollettino et al., 2020). However, to foster disaster preparedness in regions less susceptible to natural hazards, education emerges as a critical tool. Education can act as a substitute for direct disaster experience by equipping individuals with the knowledge and skills to anticipate the impacts of hazards and comprehend disaster risks (Hoffman & Muttarak, 2017).

To effectively promote disaster preparedness within an educational framework, learners need exposure to an educational approach that enhances their mastery level of understanding on the natural hazards and on how to be prepared from it. The development of Science, Technology, Engineering, and Mathematics (STEM) Education not only enriches learners' mastery level of understanding but also equips them with the interdisciplinary skills necessary to address contemporary environmental challenges (Gao et al.,2020). STEM subjects play a crucial role in augmenting students' preparation to cultivate a heightened awareness and commitment to sustainability (Del Cerro Velazquez and Lozano Rivas, 2020). As highlighted by Kelley and Knowles (2016), due to the demand for STEM skills to meet these challenges, concerns for improving STEM Education perpetually prosper.

However, the onset of the COVID-19 pandemic has introduced new challenges as the education landscape shifted towards a new mode of knowledge acquisition. In the context of the Philippines, modular distance learning has become the predominant approach. Filipino educators are confronted with the formidable task of delivering high-quality STEM education within this context. Moreover, this shift has resulted in the inability of schools to conduct essential face-to-face activities such as earthquake drills, crucial for disaster preparedness. The only viable means of promoting disaster preparedness in this new learning mode is to integrate activities related to disaster preparedness.

A gap has emerged between the goal of promoting disaster preparedness and the practical delivery of quality STEM education within the framework of modular distance learning. To address this gap, the researcher developed STEM modules on typhoon and earthquake preparedness for Grade 8 learners.

Research Questions

This research developed STEM modules on typhoon and earthquake preparedness to provide quality STEM education and promote disaster preparedness within the context of modular distance learning. This study answered the following specific questions:

1. What is the quality of the STEM modules developed?
2. What is the mastery level of the participants during pretest and posttest respectively?
3. Is there a significant difference in the pretest and posttest of the participants?
4. How did the STEM modules promote disaster preparedness among the participants?
5. What are the perceptions of the participants in the STEM modules developed?

Literature Review

Modular Distance Learning in the Philippines

The COVID- 19 reshaped our education. Face-to-face learning which is the conventional arrangement for learning has been stopped to ensure public health and safety (Pe Dangle & Sumaoang, 2020), thus continuing educational endeavor has been a major concern (Cahapay, 2021). In the Philippines, an initiative called Basic Education- Learning Continuity Plan (BE- LCP) developed by the Department of Education had paved the way for innovations of various modes for distance learning to respond to the need for continuing education amid the limitations due to COVID-19 situation (Cahapay, 2021). In distance learning delivery modality learning occurs in a set-up where teachers and learners are geographically far from each other, which convenient respond to the new normal. This modality has three variations namely Modular Distance Learning (MDL), Online Distance Learning (ODL), and TV/Radio-Based Instruction (Pe Dangle and Sumaoang, 2020 from the works of Quinones, 2020). In the global scope, implementation of ODL is popular. However, as cited by Zohra et al. (2020) from the works of Jawida et al. (n.d.) such type of distance learning modality is hindered by the access of internet connection of some students. Thus, according to Bernardo (2020), as cited by Pe Dangle and Sumaoang (2020), modular distance learning has been popular in the Philippines as it is the most favored type of distance delivery modality as per conducted survey of the Department of Education. In the study conducted by Cahapay (2021), it is preferred as it doesn't need electricity and access to the internet. In fact, according to the survey conducted by the SWS, Filipino learners who are enrolled in modular distance learning during the time of pandemic reach 80 percent or around 23.8 million (Lalu, 2021).

As cited from the works of Sweet (2020) by Cahapay (2021), this type of learning delivery modality uses printed modules that contain details about the topic, some learning activities, and assessments to measure understanding. Independent study is developed and enhanced as this type of distance learning modality is self-paced and fosters responsibility among learners and they feel empowered to complete the activities given in the module (Nardo, 2017 as cited by Pe-Dangle and Sumaoang, 2020). However, according to Pe Dangle and Sumaoang (2020), learners needed to be genuinely disciplined and motivated to complete their modules.

Promoting Disaster Preparedness through Education

The Philippines' geographical location, situated in the Pacific Ring of Fire and near the Pacific Ocean, exposes its population to seismic and volcanic activities as well as typhoons (Valenzuela et al., 2020 & Bollettino et al., 2020). Vulnerability to disasters is pronounced in communities ill-prepared for these natural hazards (Valenzuela et al., 2020). Disaster preparedness, emphasized in Disaster Risk Reduction and Management (DRRM) activities, aims to reduce vulnerability and enhance coping abilities to mitigate the impact of inevitable natural hazards (Salita et al., 2020). Preparedness, as defined by Bollettino et al. (2018), involves processes executed by policymakers, communities, and individuals to alleviate the effects of hazards.

According to Bollettino et al. (2018), preparedness measures, such as stockpiling emergency supplies and formulating family evacuation plans, are crucial for minimizing casualties and damages. Individual preparedness is integral to resilience, a key goal of Sustainable Development Goal 13 (Hoffman & Muttarak, 2017). While firsthand experience with natural hazards tends to drive preparedness, areas with low susceptibility must not be complacent, considering the potential hazards posed by climate change (Valenzuela et al., 2020). Education plays a pivotal role in promoting disaster preparedness, serving as a substitute for direct disaster experience, enabling individuals to anticipate and understand risks (Hoffman & Muttarak, 2017).

Children, identified as particularly vulnerable during natural disasters, benefit from education and involvement in disaster planning to reduce their vulnerabilities and communicate risks to their families and communities (Mitchell et al., 2009). In the Philippines, Republic Act No. 10121 mandates the integration of disaster risk reduction into school curricula (Napere & Canencia, 2014). Despite pre-pandemic initiatives like earthquake drills, the global spread of COVID-19 halted these activities, prompting the need to incorporate disaster preparedness into new modes of learning.

STEM Education in the Philippines

According to Margot and Kettler (2019), both primary and secondary classrooms are integrating STEM curriculum and pedagogy in their schools to address the need for more STEM literate workers. Solving a real-world problem in a complex designed system where students use knowledge and skills from multiple disciplines that relate to their everyday lives should be mirrored in the integrated STEM teaching approaches (Wang et al., 2020). Thus, the call for an interdisciplinary approach is emphasized to learn and teach STEM disciplines in an integrative way (Shernoff et al.,2017) through maximizing project-based learning, engineering design-based studies, or problem-based learning strategies (Sutaphan & Yuenyong, 2019).

The vision that stresses STEM Education as a roadmap to innovation and progress is being shared by developing countries like the Philippines. In the Philippine setting, educational sectors initiated and pursue quality in Philippine STEAM Education through national development plans (Morales et al., 2019). These development plans include: (1) curricular reforms, like the Outcome-Based Education (CHED 2012) and the approved K-12 track series in 2013 by the Department of Education (DepEd) that structured STEM as one of the strands in the school curriculum to let the students acquire knowledge of STEM-related disciplines (Sutaphan & Yuenyong, 2019); (2) setting standards in the Philippine Quality Framework (PRF) to assure quality (TESDA 2012); and (3) establishing PPST to qualify teachers (DepEd, 2017). Furthermore, the relationship between STEM and Agri-fisheries and Arts fields is strengthened by the

Commission on Higher Education (CHED) through grant-in-aid programs (Morales et al., 2019).

Seven Stages of Contextualized STEM Teaching Approach

Sutaphan and Yuenyong (2019) suggested a context-based STEM Education teaching approach that has seven stages which are the following: (1) Identification of Social Issues; (2) Identification of Potential Solutions; (3) Need for Knowledge; (4) Decision- making; (5) Development of prototype or product; (6) Test and evaluation of the Solution; and (7) Socialization and Completion of Decision Stage.

Studies like developing STEM lesson plan to formulate refreshment drink (Guarin et al., 2019), develop ice cream products from (Villaruz et al., 2019), develop household power consumption calculator app (Ebal et al., 2019), making healthier local snack (Masita et al., 2019), design biogas from animal's dung (Setiawan et al., 2021), designing moringa leaf tea (Koes- H et al. 2021), tempeh making (Adita & Yuenyong, 2021), develop air purifier for smog problem (Ratnaningtyas et al., 2022) and many more uses 7- stage context-based STEM Education teaching approach as a format in developing STEM lesson plan.

Methodology

Research Design

This is a mixed-method study using one group pretest and posttest design with qualitative support. The quantitative data gathered were used to measure participants' mastery level of understanding on typhoon and earthquake preparedness and attest if there was a significant difference between their pretest and posttest. Meanwhile, a qualitative research design in the form of an open-ended questionnaire was used to assess the perceptions of the participants on how the STEM modules helped in improving mastery level of understanding typhoon and earthquake preparedness and explored the challenges encountered by the participants in using the STEM modules.

Participants

The participants of this study were the selected thirty-two (32) Grade 8 students of a community secondary school in the municipality of Lopez Jaena, Misamis Occidental, Philippines. There were nine (9) males and twenty-three (23) females.
The process of selection was done by distributing first the consent forms to all Grade 8 learners in the said school. There were thirty-two consent forms retrieved. The inclusion in selecting the participants was the following: (1) signed and returned the consent forms and (2) officially enrolled in the S.Y. 2021-2022.

Instruments

The research instrument employed in this study encompassed a comprehensive set of tools aimed at measuring the effectiveness of the developed STEM modules. The achievement test, consisting of an adapted 20-item pretest and posttest, derived from published modules, underwent scrutiny by STEM experts for relevance. The Most Essential Learning Competencies (MELCS) were utilized to ensure alignment with content standards, performance standards, and essential learning competencies. The two STEM learning modules on Typhoon and Earthquake Preparedness underwent iterative development, with revisions based on feedback from consulted STEM experts. An open-ended questionnaire, developed by the researcher and validated by STEM experts, gauged participants' perceptions of the modules effectiveness and identified challenges encountered. Three rubrics were employed, including a STEM rubric from Tecson et al. (2019) for module evaluation by STEM experts, and two rubrics developed by the researcher for assessing students' STEM outputs, validated by both STEM experts and MDRRMO personnel.

Procedure

Figure 1 shows the procedure of the study. MELCS was used as reference in developing the STEM modules. The evaluation process of the developed STEM modules involved rigorous scrutiny by STEM experts, leading to subsequent improvements and revisions based on their comments and suggestions. Prior to pilot testing, formal authorization was obtained from the principal of the chosen community secondary school in Lopez Jaena, Misamis Occidental. Consent forms were then distributed to Grade 8 students' parents, with 32 forms retrieved. Subsequently, the researcher collected necessary information from class advisers, including complete names, addresses, and contact numbers. Collaborating with the advisers, a two-week interval schedule for the dissemination and retrieval of STEM modules was established. To ensure unbiased pretest assessment, the researcher conducted home visitations before distributing the STEM modules. The modules, focusing first on earthquakes and later on typhoons, were distributed and collected at two-week intervals, accompanied by the retrieval of corresponding STEM outputs—emergency preparedness plans and emergency kits. Posttests were conducted after the final module, followed by the open-ended questionnaires to gauge participants' perceptions of the developed STEM modules.

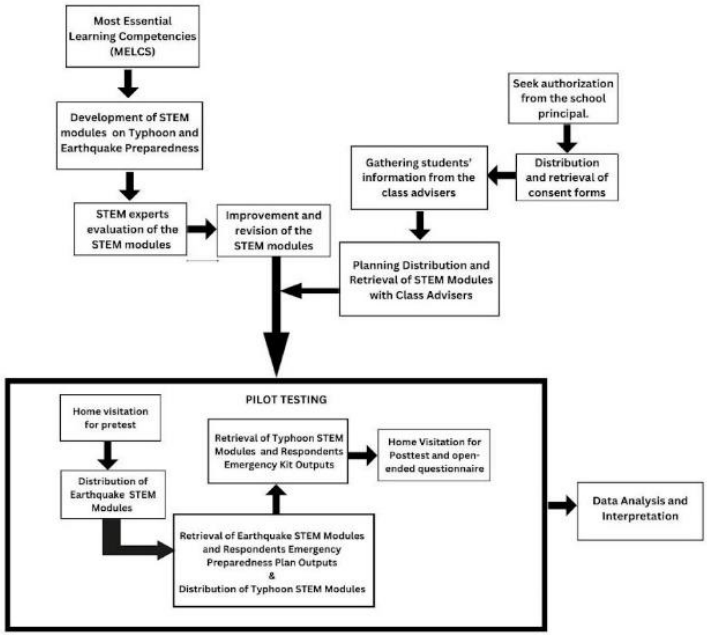


Figure 1. *Procedure of the Study*

Ethical Considerations

Since the participants of this study were minors, the researcher asked first parental consent to perform this research. Coding was also made by the researcher to ensure confidentiality. The researcher assigned unique identifiers such as "SE" for STEM experts, "ST" for Science teachers, and "S" for students.

Results and Discussion

Quality of the Developed STEM Modules on Typhoon and Earthquake

The development of the STEM modules starts by referring to MELCS. Then the 7 Stages of Context-based STEM Teaching Approach by Sutaphan and Yuenyong was maximized as the format to make respondents experienced to integrate knowledge in different disciplines. The developed STEM modules on typhoon and earthquake preparedness were evaluated by the STEM experts consulted.

Table 1 shows the rating of the STEM learning modules developed. The researcher used an adapted rubric from Tecson et al. (2019) and distributed it to the STEM experts to evaluate the STEM learning modules developed. Based on the results the STEM modules developed got the highest rating on the learning content criterion with a 3.883 average score for the Earthquake STEM module and 3.916 average scores for the Typhoon STEM module. The STEM module on earthquakes got the lowest rating in the learning objectives criterion with an average score of 3.667. Meanwhile, the STEM learning module on typhoons got the lowest rating in the degree of contextualization criterion with an average score of 3.625

Table 1. *Rating of the STEM Modules*

	Learning Objectives	*Learning Content*	*Degree of Contextualization*	*STEM Lesson Stage*
Earthquake STEM Modules	3.667	3.883	3.668	3.786
Typhoon STEM Modules	3.833	3.916	3.625	3.857

Using the intervals and descriptions adapted from Maurac (2016) shown in Table 2, the overall rating of the STEM modules developed was excellent.

Table 2. *Intervals and Interpretations for the STEM Modules' Rating*

Intervals	*Interpretation of Responses*
3.25 – 4.0	Excellent
2.50 – 3.24	Very Good
1.75 – 2.49	Good
1.00 – 1.74	Needs Improvement

Moreover, the researcher considered the comments and suggestions made by the STEM experts consulted as shown in Table 3 to revise

and further improve the quality of STEM learning modules. The themes of the comments and suggestions were the following: (1) create an objective for an affective domain, (2) improve the degree of contextualization, (3) include activities in every lesson, (4) add and improve images on some parts of the lessons, (5) add questions that will reflect personal experiences and (6) rearrange the sequence of the items in the chapter test.

Table 3. *STEM Experts' Comments and Suggestions*

Theme	*Comments/ Suggestions*
Create objectives for the affective domain.	*SE2: "Create learning objective for affective domain."* *SE4: "Add affective domain objective."*
Improve the degree of contextualization	*SE1: "I would like to see more information on the contextualized area (chosen locality) like iguide ang learners in narrowing down their reflection of the Earthquakes/Typhoons situation from a broader scope to a narrow one (chosen locality) for example sa identification of social issues na stage (specific na issue sa locality). (I would like to see more information on the contextualized area (chosen locality), like guide the learners in narrowing down their reflection of the Earthquakes/Typhoons situation from a broader scope to a narrow one (chosen locality, for example in identification of social issues stage (specific issue in the locality))."* *SE3: "Overall, it is very informative and just be cautious on providing contextualized information on the student."*
Include activities in every lesson.	*SE3: "Suitable activity for every lesson is very important."* *SE4: "Can you add a mini activity every lesson to make it interactive?"*
Add and improve images on some parts of the lessons	*SE4: "Maybe you can add illustrations of each intensity scale. Add images for before, during and after earthquake strikes."*
Add questions that will reflect personal experiences	*SE2: "Add a question that will reflect their personal experience with earthquakes. Add a question regarding their personal experience during a typhoon. In the identification of potential solutions, asked "During an earthquake, are there things you need to prepare to survive? Or what are the things you need to do to survive?"*
Rearrange the sequence of the items in the chapter test	*SE3: "In post-test you can rearrange the sequence of each number to really determine students' knowledge about it."*

Participants' Mastery Level During Pretest and Posttest

As reflected in Table 4, the participants' MPS in their pretest is 43.13% mastery level with a mean of 8.63 and standard deviation of 2.72. Using the description of the Department of Education Memorandum Order No. 160 series of 2012 as shown in Table 5, results implied that on the average most of the participants showed an AVERAGE mastery level in the pretest for typhoon and earthquake preparedness.

Table 4. *Participants' Pretest MPS, Mean and Standard Deviation*

Raw Score	*f*	*fx*	*MPS*	*Description*	*Mean*	*SD*
1	1	1	43.13%	Average	8.63	2.72
5	2	10				
6	3	18				
7	2	14				
8	8	64				
9	5	45				
10	6	60				
11	2	22				
13	2	26				
16	1	16				
	∑f =32	∑fx=276				

Table 5. *DepEd Perspective of Mastery Level using Mean Percentage Score (MPS)*

Mean Percentage Score (Mps)	*Description*
96 % - 100 %	Mastered
86 % - 95 %	Closely Approximating Mastery
66% - 85 %	Moving Towards Mastery
35% - 65 %	Average
16 % - 34 %	Low
5 % - 15 %	Very Low
0 % - 4 %	No Mastery

Meanwhile in Table 6, it is shown that the participants' MPS in their posttest increased to 70.47% mastery level with a mean of 13.91

and standard deviation of 3.04. This implied that on the average most of the participants' show a MOVING TOWARDS MASTERY level in posttest for typhoon and earthquake preparedness, one-level increased from the participants' pretest mastery level.

Table 6. *Participants' Posttest MPS, Mean and Standard Deviation*

Raw Score	*f*	*fx*	*MPS*	*Description*	*Mean*	*SD*
9	1	9	70.47%	Moving Towards	13.91	3.04
10	2	20		Mastery		
11	4	44				
12	5	60				
13	4	52				
14	1	14				
15	4	60				
16	5	80				
18	3	54				
19	2	38				
20	1	20				
	∑f =32	∑fx=451				

Significant Difference in the Performance of the Participants in the Pretest and Posttest

Table 7 presents the analysis of the significant difference in the performance of the participants in the pretest and posttest. It was found that there was a significant difference in the performance of the participants in the pretest and posttest since the p-value was less than 0.05 level of significance. The t-value of -11.81 signified that the mean score of the participants in the pretest was less than their mean score in the posttest. This implied that on average the performance of the participants improved in the posttest. Moreover, this also implied that the STEM modules helped participants improve mastery level in understanding typhoon and earthquake preparedness.

Table 7. *Analysis on the Significant Difference in the Performance of the Respondents in the Pretest and Posttest*

Test	*Mean Score*	*t-value*	*p-value*
Pretest	8.63	-11.81	0.000*
Posttest	13.91		

*H0: There is no significant difference in the performance of the respondents in the pretest and posttest. *Significant at p < 0.05 level of significance*

Promoting Disaster Preparedness through Creating Emergency Preparedness Plans and Emergency Kits

According to Hoffman and Muttarak (2017), stockpiling of emergency supplies or preparing a family evacuation plan are just some of the examples of preparing for disasters to reduce the number of casualties and lessen damages from hazards. Thus, to promote disaster preparedness using the STEM modules, activities making emergency preparedness plans and emergency kits were included as respondents' final outputs. These activities are also stipulated in the MELCS.

However, it is important to note that in this study, there are limitations set in creating emergency preparedness plans and emergency kits. The limited specific elements in creating emergency preparedness plans and predetermined categories that must be included in the emergency kits was checked and approved by the MDRRMO personnel consulted simultaneous in face validating the rubrics that was used to evaluate these respective outputs. The important elements in creating the emergency preparedness plan only includes: (1) emergency route exits, (2) monthly safety assessments, (3) roles and responsibilities of family members, (4) emergency contacts, and (5) emergency kits. Meanwhile, the categories of essential items that must be included in the emergency kits were only limited to: (1) items that can signal for help, (2) items for illumination, (3) items for hydration, (3) items for hydration, (4) items for nutrition, (5) items for medication, (6) items for hygiene, and (7) important documents.

Table 8 presents the scores of the participants in making the emergency preparedness plan. It was found that most of the respondents had very satisfactory scores in making the emergency preparedness plan since they got scores in the range 21-30. In this level, the following things were observed: (1) considered 3 elements of emergency preparedness plan, (2) the project showed good creativity in design, (3) few grammatical errors were seen, (4) emergency preparedness plan met expectation, and (5) average effort was recognized.

The mean score of 29.09 meant that on average the respondents had a very satisfactory rating in making the emergency preparedness plan with a standard deviation of 3.47. However, there were 11 respondents (34.4%) who had outstanding ratings in making the emergency preparedness plan. In this level, the following things were observed: (1) considered all elements of an emergency preparedness plan, (2) the project showed excellent creativity in design, (3) free grammatical errors were seen, (4) emergency preparedness plan exceeded expectation, and (5) superior effort was recognized.

Table 8. *Participants' Scores in Making the Emergency Preparedness Plans*

Score	*Description*	*Frequency*	*Percentage*	*Mean*	*SD*
1 – 10	Poor	0	0	29.09	3.47
11 – 20	Satisfactory	0	0		
21 – 30	Very satisfactory	21	65.6		
31 – 40	Outstanding	11	34.4		
Total		32	100		

Table 9 presents the scores of the participants in making the emergency kit. It was found that most of the respondents had very satisfactory scores in making the emergency kit since they got scores in the range of 31-40. In this level, the following things were observed: (1) emergency kit included 6 categories of essential items, (2) the project showed excellent creativity in design, (3) the emergency kit received few damages after the drop test for durability, (4) the emergency kit was slightly wet after the waterproof test, (5) the emergency kit was easy to carry, and (6) most materials used in the emergency kit were not locally available and less expensive.

The mean score of 36.03 meant that on average the respondents had a very satisfactory rating in making the emergency kit with a standard deviation of 4.88. However, there were 5 respondents (15.6%) who had outstanding ratings in the make the emergency kit. In this level, the following things were observed: (1) emergency kit included all categories of essential items, (2) the project showed outstanding creativity in design, (3) the emergency kit received no damages after the drop test for durability, (4) the emergency kit was waterproof, (5) the emergency kit was very easy to carry, and (6) all materials used in the emergency kit were locally available and not expensive.

Table 9. *Participants' Scores in Making the Emergency Kits*

Score	*Description*	*Frequency*	*Percentage*	*Mean*	*SD*
1 – 10	Did not meet expectations	0	0	36.03	4.88
11 – 20	Fairly satisfactory	0	0		
21 – 30	Satisfactory	5	15.6		
31 – 40	Very satisfactory	22	68.8		
41 – 50	Outstanding	5	15.6		
Total		32	100		

Perceptions of the Respondents

Table 10 shows some of the perceptions of the participants on how the STEM modules helped in improving their mastery level of understanding about typhoon and earthquake preparedness

Table 10. *Participants Perceptions on How the STEM Modules helped in Improving their Mastery Level of Understanding*

Theme	*Responses*
By the concepts included in the STEM learning modules, respondents improved their conceptual understanding and preparedness on earthquakes and typhoons.	*S9: "Gipalambo niya ang akong kaalaman mahitungod kung unsay buhaton pag naay linog sa before, during and after. Gipalambo ang akong kaalam mahitungod sa unsa ang kinahanglan buhaton kong mag bagyo. (It improved my knowledge on what to do before, during and after an earthquake occurs. It improved my knowledge about the necessary things to do if there's a typhoon.)"* *S13:"Nakatabang nako ang module about sa earthquake (earthquake) kay naa sa module ang mga buhaton nato kung unsay mga buhaton kong naay muabut na linod- or unsa pang mga hitabu- about sa earthquake. Nakatabang ni na module pod sa typhoon tapos naa tan nga mga wala pa nimo na hibaw-an. (The module about earthquakes helped me because it is included in the module the things that needed to do if there's an earthquake that will occur and other happenings about earthquakes. Also, the module on typhoons helped me as everything that I didn't know about typhoon are already here.)"* *S31: "Sa pag explain og sa pagpahibalo kong unsa atong buhaton kong aduna may moabot na linog sa atong lugar. Nakatabang kini kanako kay ginaexplain gyud ani ng STEM na module ang mga buhaton kong naay katalagman ng mahitabo. (Through explaining and informing on what to do if an earthquake occurs in our place. It helped me because the STEM learning module explained the things that I needed to do if there's a disaster that will happen."*
By developing project management skills, innovation, and deepening critical thinking.	By developing project management skills, innovation, and deepening critical thinking

By guiding and providing good questions.	*S5: "The STEM learning module guide and giving (gave) me good questions for me to give the wright (right) answeres (answers)."*
By making the STEM outputs.	*S10, S14: "It improve (improved) my conceptual understanding by making a (an) emergency preparedness plan and emergency kit because I've realized that emergency preparedness plan and an emergency kit is important because when there's a disaster came, the whole family is ready, and it will never be panic (prevent from getting panic) because you have already a preparedness plan and emergency kit."*

Although the developed STEM modules have evident results in improving the mastery level understanding of the participants about typhoon and earthquake preparedness, there were some participants who encountered challenges in using the STEM modules as shown in Table 11. The theme of the responses was the following: (1) challenged in making the expected STEM learning outputs, (2) some questions were hard to answer, (3) some activities were difficult to do especially tracing PAR, describing paths of typhoon and making vlogs, (4) language barrier, (5) there's no other knowledgeable person in the house that can be consulted, (6) lack of time, (7) financial problem, and (8) lack of materials and other external factors. Some of these challenges were similar in the study of Pe Dangle and Sumaoang (2020). Results from their study shows the following concerns: (1) learners don't have ample time to finish all the modules and (2) the topics must be simplified.

Table 11. *Challenges in Using the STEM Modules*

Theme	*Responses*
Challenged in making the expected STEM learning outputs.	*S5: "The challenges (challenge) I faced in this STEM learning module on typhoon is the emergency kit making"* *S17:"Ang lisod nako nga naagian sa pagbuhat sa STEM learning module kay kanang paghimo og earthquake preparedness plan nga balay. (The challenged I faced in doing the STEM learning module is making the house of the emergency preparedness plan.)*
Some questions are hard to answer	*S11:"Usahay maglisod ko ug answer sa module sa typhoon. (Sometimes I am having a hard time answering the module on typhoon.)"*
Some activities are difficult to do especially tracing PAR, describing the paths of the typhoon, and making vlogs.	*S6 & S17:"Ang lisod nga naagian sa pagbuhat og STEM learning module sa typhoon is katong i described ang tropical depression Vinta ug katong mag trace sa Par. (The difficulty I faced in doing the STEM learning on typhoon is the activity that involves describing (the path) of tropical depression Vinta and the activity that task to trace the PAR)."* *S9:"Ang mga DO THIS kay mga essay man gud lisudan ko. Sa paggama sa vlog kay maulaw man gud ko mag video video ug exact pa gyud 3:00 minutes (The DO THIS because some of it are essays. I find it difficult. Also, in doing the vlog because I feel shy taking video of myself and it requires to be exactly 3 minutes)."*
Language barrier.	*S20: "The challenges (challenge) that I faced while doing my STEM learning module is I cannot understand what the module means (,) its(it's) not because the letters are not clear (,) its (it's) because I'm not good at English Naglisod ko ug sabot sa mga meaning sa kada explanation kay dili kaayo ko kasabot ug english. (I was having a difficulty to understand the explanation because I cannot fully understand English.)"*
There's no other knowledgeable person in the house that can be consulted.	*S15:"Nangutana ko sa akong mama nga unsaon ni sya og nangutana na pod ko sa akong anti nga unsaon ni pag- answer na pag wala pod sila kasabot gi reaserch nako. (I asked my mom and aunt on how to answer this and since they don't understand it also, I searched on it.)"*
Lack of time.	S16: *"Usa pod ang oras, kay mag- answer pa man sa usa ubang module. Kay isa man kini sa requirement, mag-overtime gyud sa pagbuhat niini aron dakog grado! (Also the time, because I need to answer the other modules. Since this is one of the requirements, I need to do an overtime in doing this to get a high grade!)"*
Financial problem.	*S29: "It is so hard doing projects if we do not have money. Money is badly needed nowadays because we are facing the pandemic. Computers do need money very badly because of the internet connections. We can not (cannot) connect to the internet if (we) do not have loads. And also, we do not have enough money to buy the materials needed in the projects."*

	S10& S14: "The challenges that I faced when doing the STEM learning module (are the following: (1) brownout; (2) incomplete things when making the emergency preparedness plan and emergency kit; (3) the ballpen is out of ink; and (4) the surrounding is noisy so I cannot focus."
Lack of materials and other external factors. :	*S16:"Dili dayon ka pangutana sa maestra ug unsaon pagbuhaton nga mga projects kay wala may face to face nga nahitabo. Dili pod ka text kay walay budget sa load kay gi priority man ang ubang mga pangangailangan sa balay. (I cannot immediately ask question to the teacher because there's no face-to face classes. I cannot text also because there is no budget for the cellular load because the other needs in the house are prioritized.)"*

Conclusion

In conclusion, the implementation of STEM modules focusing on typhoon and earthquake preparedness yielded positive outcomes, as evidenced by improved mastery level of understanding among participants—from AVERAGE to MOVING TOWARDS MASTERY LEVEL. The significant difference observed in pretest and posttest results underscores the modules' effectiveness in improving the respondents' mastery level of understanding typhoon and earthquake preparedness. In addition, the positive perception of the participants regarding how the STEM learning modules helped in improving their mastery level of understanding, despite the encountered challenges, underscores their value and effectiveness. Meanwhile, the attainment of a very satisfactory rating in emergency preparedness plans and emergency kits outputs reflects the modules' success in fostering preparedness among the participants.

This research contributes valuable insights into the potential of STEM education to not only enhance mastery level of understanding but also cultivate essential skills and preparedness, even in the face of unforeseen obstacles. Moreover, when considering the outcomes of this study within a broader context, this could also significantly contribute to the realization of Sustainable Development Goals (SDG) 4 and 13. While the study was conducted in a rural setting, this also hold potential relevance to SDG 11, particularly in addressing the ambitious goal of enhancing urban resilience to the impacts of climate change and reducing risks associated with disasters.

Furthermore, the researcher recommends implementation of the STEM modules to a large-scale respondent to cross-validate the results.

References

Adel, R. (2019, Feb 5). Only 36% of Pinoys in Harvard Humanitarian Initiative poll 'fully prepared' for disasters. Philstar.com. https://www.philstar.com/headlines/2019/02/05/1891113/only-36-pinoys-harvard-humanitarian-initiative-poll-fully-prepared-disasters

Adita, A., & Yuenyong C. (2021). STEM Learning Activity through Tempeh Making Process. Journal of Physics: Conference Series 1835 (1), 012050.

Barrett, B. S., Moran, A. L., & Woods, J. E. (2014). Meteorology meets engineering: An interdisciplinary STEM module for middle and early secondary school students. International Journal of STEM Education,1(1),6. https://doi.org/10.1186/2196-7822-1-6

Bolletino, V., Alcayna, T., Enriquez, K., & Vinck, P. (2018). Perceptions of Disaster Resilience and Preparedness in the Philippines.

Bolletino, V., Alcayna-Stevens, T., Sharma, M., Dy, P., Pham, P., & Vinck, P. (2020). Public Perception of Climate Change and Disaster Preparedness: Evidence from the Philippines. Climate Risk Management. https://doi.org/10.1016/j.crm.2020.100250.

Cahapay, M. B. (2021). Philippine Basic Education Learning Continuity Plan: Creating Space for Indigenous Peoples toward Inclusive post-COVID-19 Education. International Journal of Pedagogical Development and Lifelong Learning, 2(1). https://doi.org/10.30935/ijpdll/9294.

Cajurao, E. C., Cajurao, I. P., Romero, J. N., Bolivar, J. T., Diestro, J. L., & Merida, M. C. E. (2023). Filipino-Based Learning Activity Sheets (LAS): Impacts on Grade 10 Students' Conceptual Understanding of Plate Boundaries and Earthquake. International Journal of Multidisciplinary: Applied Business and Education Research, 4(7), 2535-2543. https://doi.org/10.11594/ijmaber.04.07.30

Del Cerro Velazquez F. and Lozano Rivas F. (2020). Education for Sustainable Development in STEM (Technical Drawing): Learning Approach and Method for SDG 11 in Classrooms. Sustainability 12(7):2706. https://doi.org/10.3390/su12072706

Ebal, C. D., Luga, M. J., Flores, M. R., & Zabala, D. J. (2019). Linear Equations in Two Variables STEM Education Learning Activities: Developing the Household Power Consumption Calculator. Journal of Physics: Conference Series, 1340.

English, L. D. (2016). STEM education K-12: perspectives on integration. International Journal of STEM Education,3(1). https://doi.org/10.1186/s40594-016-0036-1.

Gao, X., Li, P., Shen, J., & Sun, H. (2020). Reviewing assessment of student learning in interdisciplinary STEM education. International Journal of STEM Education,7(1). https://doi.org/ 10.1186/s40594-020-00225-4

Guarin, R., Buan, A., Malicoban, E., Barquilla, M., & Yuenyong, C. (2019). Formulating Refreshment Drink Activity Utilizing STEM Education for Grade 8 Learners. https://doi.org/10.13140/RG.2.2.12839.91049.

Hoffman, R., & Muttarak, R. (2017). Learn from the Past, Prepare for the Future: Impacts of Education and Experience on Disaster Preparedness in the Philippines and Thailand. World Development, 96, 32-51. http://dx.doi.org/10.1016/j.worlddev.2017.02.016.

Ivankova, N., Creswell, J., & Stick, S. (2006). Using Mixed- Methods Sequential Explanatory Design: from Theory to Practice. SAGE Journals,18(1),3-20. https://doi.org/10.1177/1525822X05282260.

Kelley, T. R., & Knowles, J. (2016). A conceptual framework for integration. International Journal of STEM Education. https://doi.org/10.1186/s40594-016-0046z.

Kelley, T. R., Knowles, J., Holland, J. D., & Han, J. (2020). Increasing high school teachers' self-efficacy for integrated STEM instruction through a collaborative community of practice. International Journal of STEM Education,7(1). https://doi.org/10.1186/s40594-020-00211-w.

Koes-H, S., Jewaru, A. A. L., Fuadah, F., Amalia, N. U., Sutaphan, S., Yuenyong, C., & Yuenyong, J. (2021). Developing the lesson plan of STEM education: designing Moringa leaf tea. Journal of Physics: Conference Series, 1835(1), 012047. https://doi.org/10.1088/1742-6596/1835/1/012047

Lalu, G. P. (2021, March 2). 42% of school-age Filipinos don't use devices for distance learning SWS. INQUIRER.net. https://newsinfo.inquirer.net/1402187/42-of-school-age-filipinos-dont-usedevices-for-distance-learning-sws.

Lassoued, Z., Alhendawi, M., & Bashitialshaaer, R. (2020). An Exploratory Study of the Obstacles for Achieving Quality in Distance Learning during the COVID-19 Pandemic. Education Sciences, 10(232). doi:10.3390/educsci10090232.

Mahusay, E. (2020). Adversaries on COVID-19 Set Forth an Argument Onward to Educational Endeavor: Resulting to Develop a Modular Concept in the Learning Process. American International Journal of Science Research, 5(2).

Masita, R., Sutaphan, S., & Yuenyong, J. (2021). Developing Lesson Plan on the Healthier Local Snack STEM Education. Asia Research Network Journal of Education, 1(1), 43-49. ThaiJO. https://so05.tci-thaijo.org/index.php/arnje/article/view/250627

Mattar, J. (2018). Constructivism and Connectivism in Education Technology: Active, Situated, Authentic, Experiential, and Anchored Learning. RIED:Revista Iberoamericana de Educación a Distancia, 21(2),201. https://doi.org/10.5944/ried.21.2.20055.

Maurac, H., & al, e. (2016). Development and Implementation of Activity-based- Teaching Materials on Heat Transfer: Impact on Students Conceptual Understanding.

Mitchell, T., Tanner, T., & Haynes, K. (2009). Children as Agents of Change for Disaster Risk Reduction: Lessons from El Salvador and the Philippines.

Morales, M. E., Anito, J. C., Avilla, R. A., Abulon, E. R., & Palisoc, C. P. (2019). Proficiency Indicators for Philippine STEAM (Science, Technology, Engineering, Agri/fisheries, Mathematics) Educators. Philippine Journal of Science, 148(2).

Napere, R. D., & Canencia, O. P. (2014). Exploring the Disaster Management of Teachers and Pupils in Iligan City, Philippines. IAMURE International Journal of Ecology and Conservation, 8. https://doi.org/10.7718/ijec.v8i1.749

Ovais D. (2023) Students' sustainability consciousness with the three dimensions of sustainability: Does the locus of control play a role?. ScienceDIrect. Regional Sustainability.4(1). 13-27 https://doi.org/10.1016/j.regsus.2023.02.002

Pe Dangle, Y. R., & Sumaoang, J. D. (2020). The Implementation of Modular Distance Learning in the Philippine Secondary Public Schools. 3rd International Conference on Advanced Research in Teaching and Education.

Ratnaningtyas, A.,Nugraheni E., & Yuenyong C. (2022). Developing the SMOG Problem in Indonesia STEM Education Learning Activity. Asia Research Network Journal of Education, 2(3), 127-134.

Salita, C., Tiongco, R. E., & Kawano, R. (2020). Assessment of School Teachers' Disaster Preparedness Using the Extended Parallel Process Model: A Cross-Sectional Study in Angeles City, Philippines. Journal of Public Health: From Theory to Practice. https://doi.org/ 10.1007/s10389-020-01237-8

Setiawan, A., Yuenyong, C., Sutaphan S., & Yuenyong J (2021). Developing lesson plan of the biogas from animal's dung STEM education. Journal of Physics: Conference Series 1835 (1), 012044.

Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017). Assessing teacher education and professional development needs for the implementation of integrated approaches to STEM education. International Journal of STEM Education,4(1). https://doi.org/10.1186/s40594-017-0068-1.

Sutaphan, S., & Yuenyong, C. (2019). STEM Education Teaching approach: Inquiry from the. Journal of Physics: Conference

Series,1340,012003. https://doi.org/10.1088/1742-6596/1340/1/012003.

Tecson, C., Salic-Hairulla, M., & Nabua, E. (2019). Identification of Species in Nunungan: Basis for Contextualized Biodiversity Stem Lesson. Program of Abstract, 6th National Research Conference in Science and Mathematics Education.

Valenzuela, V. P., Esteban, M., Takagi, H., Danh Thao, N., & Onuki, M. (2020). Disaster Awareness in Three Low Risk Coastal Communities In Puerto, Princesa CIty, Palawan, Philippines. International Journal of Disaster Risk Reduction,101508. https://doi.org/10.1016/j.ijdrr.2020.101508.

Villaruz, E. J., Cardona, M. C., Buan, A. T., & Barquilla, M. B. (2019). Ice Cream STEM Education Learning Activity: Inquiry from the Context. Journal of Physics: Conferences Series, 1340.

Wang, H.-H., Charoenmuang, M., Knobloch, N. A., & Tormoehlen, R. L. (2020). Defining interdisciplinary collaboration based on high school teachers' beliefs and practices of STEM integration using a complex designed system. International Journal of STEM Education,7(2). https://doi.org/10.1186/s40594-019-0201-4.

Wen, X., Yang, Z., & Wang, Z. (2018). Research on enhancing non-major students' abilities based on constructivism. ICIET '18.

Zhbanova, K. S. (2019). Editorial: Developing Creativity Through STEM Subjects Integrated with The Arts. Journal of STEM Arts, Crafts, and Constructions, 4(1), 1-15.

Affiliations and Corresponding Information

Ruem P. Tubo, MSciEd
Mindanao State University
Iligan Institute of Technology – Philippines

Monera Salic- Hairulla, PhD
Mindanao State University
Iligan Institute of Technology – Philippines

Edna B. Nabua, PhD
Mindanao State University
Iligan Institute of Technology – Philippines

Elesar V. Malicoban, MSciEd, MAS
Mindanao State University
Iligan Institute of Technology – Philippines