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Integration of a Localized STEM-based Learning Material in Teaching Typhoons for Grade 8 Learners

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Abstract

This study is geared towards developing a localized STEM-based learning plan for teaching typhoons to Grade 8 learners. The developed learning material would provide educators with an innovative strategy for teaching a science concept to achieve a more effective teaching and learning process. It would also help students to fully understand the topic and enhance their collaborative and problem-solving skills. Before developing the learning material, a needs assessment was completed by selected science teachers and students of different public schools in Iligan City including the target school. Likewise, the developed learning material was evaluated by the experts in this field wherein their comments and suggestions were considered in improving the material. Overall, the learning material was rated as excellent which guaranteed quality as an instrument of this study. Results also revealed that there is a significant difference between student's pretest and post-test in their academic performance.

Keywords: STEM Education, localized, learning plan

1. Introduction

Nowadays, science learning is not only about problem-solving training in the classroom. It also requires students to be able to resolve issues that are relevant to the real world. (Williams, 2011). To give solutions for concerns and problems in the real world, people need to develop 21st-century abilities including critical thinking, entrepreneurship, communication, cooperation, decision-making, leadership, problem-solving, responsibility, and creativity. Thus, the education system is changing to address contemporary educational issues by adapting several approaches. One of the educational approaches in which these individuals have developed the skills needed is the STEM approach (Ergün& Külekci, 2019; Rosli R., et al., 2019). STEM is an acronym that stands for Science, Technology, Engineering, and Mathematics. It was first mentioned by The

National Science Foundation Director J. A. Ramaley in 2001 and spread rapidly after that date (Yıldırım & Altun, 2015). STEM education enables students to apply what they have learned to their daily lives and helps teach students science, mathematics, engineering, and technology together.

Moreover, a context-based STEM Education teaching approach was suggested by Sutaphan and Yuenyong (2019). This student-centered approach 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. Several studies followed this teaching approach such as developing a STEM lesson plan to formulate refreshment drinks (Guarin et al., 2019) and teaching a science concept like biodiversity (Shaeef et al., 2024), developing a STEM module to understand typhoons and earthquakes preparedness (Tubo et al., 2024), developing an air purifier for smog problem (Ratnaningtyas et al., 2022), ice cream products (Villaruz et al., 2019), and household power consumption calculator app (Ebal et al., 2019), designing moringa leaf tea (Koes- H et al. 2021), tea village (Phan et.al., 2021), biogas from animal's dung (Setiawan et al., 2021), tempeh making (Adita & Yuenyong, 2021), making healthier local snack (Masita et al., 2019), and many more.

On the other hand, one of the aims of STEM education is to build STEM literacy (Department of Education, 2016). According to Bybee (2010), STEM literacy refers to the ability to: (1) acquire knowledge of science, technology, engineering, and mathematics; (2) understand the characteristics of STEM disciplines as forms of human efforts, including inquiry, design, and analysis processes; (3) understand how STEM disciplines shape our material, intellectual, and cultural world; and (4) engage in STEM-related issues by using ideas related to those disciplines.

STEM education is vital in improving students' STEM literacy in science classes they take in school. However, the research on promoting STEM education in a science subject in the classroom is still limited (Gülhan & Şahin, 2016). STEM education in the country is only utilized at the senior high school level in the K+12 curricula. Such utilization of the STEM education framework is not explicitly emphasized at the junior high school level. Hence, it is necessary to introduce STEM education in the lower years of high school to prepare the students' foundation if they decide to pursue STEM-related strands in senior high school and college (Tecson, 2019). Likewise, science learning in junior high school has not properly integrated STEM literacy which is why students have not been able to apply science, technology, engineering, and mathematics consciously in their daily lives (Nurlaely et al., 2017). Additionally, there were few research investigating students' perceptions of STEM activities and STEM education applied at different levels and on different subjects (Aydın & Karslı Baydere, 2019; Gülhan & Şahin, 2018; Sarı, Duygu, Şen & Kırındı, 2020). On the other hand, numerous national and international evaluations of students' learning have demonstrated that there is a need for improvement in the Philippines' performance in science and mathematics. Our country came in the lowest place out of all participating nations in the Programme for International Student Assessment (PISA) 2018 findings, which included Science as one of the topics assessed (Dela Cruz, 2022). Furthermore, according to recent PISA 2022 results, students from the Philippines are still among the least proficient in the world in math, reading, and science which only implies that the country's performance showed no significant improvement from the PISA 2018 results (Acido & Caballes, 2024).

Definitely, at the core of STEM, emphasis is placed on engaging students with real-life problems. In this context, understanding typhoons comes first among the lessons that students can be exposed to real-life problems as the destruction caused by typhoons is seen as one of the problems that most Filipinos usually encounter. Our country which is located along the typhoon belt in the Pacific, is visited by an average of 20 typhoons every year, 5 of which are destructive (Asian Disaster and Reduction Center). Thus, the study's main purpose is to develop and utilize a STEM-based learning plan for teaching typhoons in junior high school to help improve students' STEM literacy and promote STEM education in the Philippine curriculum at the junior high school level. This is also to address concerns about improving students' academic success in science.

2. Objectives of the Study

This study sought to achieve the following research objectives:

1. To Conduct a pre-assessment for science teachers to determine familiarity with STEM education and difficulties in teaching typhoons as well as students' STEM literacy
2. Develop a STEM-based learning plan on the topic of understanding typhoons
3. Determine student's academic performance through their pretest and post-test scores
4. Determine the significant difference between students' academic performance

3. Methods

The localized STEM-based learning plan on understanding typhoons is developed as detailed in the following subsections.

3.1 Data Gathering Procedure

The Basic Successive Approximation Model SAM 1) was used in this study. This is a cycle with three stages: evaluate, design, and develop. This instructional design offers an iterative framework to quickly develop engaging learning materials.

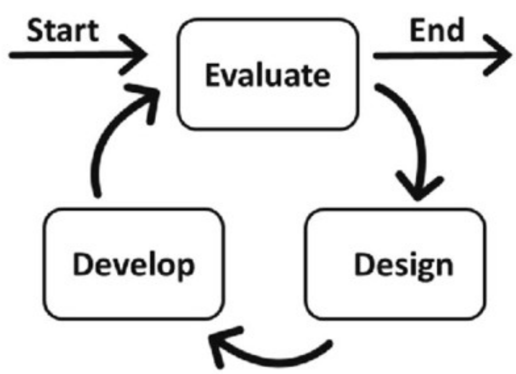

Figure 1. Basic Successive Approximation Model (SAM 1)

The study has undergone three different stages. In the evaluation stage, selected science teachers were pre-assessed to evaluate whether the localized STEM-based learning plan on the topic of understanding typhoons is necessary as well as to determine students' STEM literacy. Next, in the design stage, learning competencies from the Science Curriculum Guide on the topic of Understanding Typhoons and pre-assessment results were used to align and integrate into the lesson which served as bases for designing activities in each stage. Then, the localized STEM-based learning plan was developed and subject to implementation during the development stage. Furthermore, the implementation occurred in a certain public school in Iligan City wherein the respondents were Grade 8 learners. In conducting the implementation, the researcher sought first approval from the school head, advisers, and the students which entails their voluntary participation and awareness of the purpose of the study. In addition, the researcher further explained to the students the goal and objective of the study for them to become fully aware. At the end of the implementation, the learning material was enhanced based on the comments and suggestions of the students and observing teachers.

3.2 Needs Assessment Questionnaires for Science Teachers and Students

To determine the need for localization of the STEM learning plan, the researcher adopted and modified the work of Guiritan (2023) for science teachers' needs assessment. For students' STEM Literacy, another questionnaire was adopted from Ibrohim et al., (2020). These questionnaires were given to the key informants.

3.3 Designing and Conceptualization of the Localized STEM-based Learning Plan on Understanding Typhoons.

In designing and conceptualizing the localized STEM-based learning plan, the content, performance standards, and learning competencies were considered. The researcher adopted the STEM Education learning approach of Sutaphan and Yuenyong (2019) in developing the learning plan. The following are the different stages of the STEM learning plan.

3.3.1 Identification of Social Issues. During the initial stage, a preliminary activity was conducted to introduce the lesson, and several video showings supported by some guided questions were done to stimulate students' minds in learning the topic. To localize the lesson, images of flooding in their place were also shown for them to relate and connect their ideas and experiences. With this, they could identify the social issue of the topic. This was done on the first day of teaching within 30 minutes of the allotted time.

3.3.2 Identification of Potential Solution. This was followed by the identification of a potential solution. Students were allowed to explore and identify the possible solutions to the problem they had discovered. One example of the solution is to show it through making a model and that is a typhoon-proof house with a flood barrier, if and only if they could not come up with any other solutions. This model will be used to demonstrate how the adverse effects of typhoons such as flooding and strong winds could be mitigated which was the identified social issue of the learning plan. This was also done on the first day with an allotted time of 30 minutes.

3.3.3 Need for Knowledge. In this stage, referred to as the need for knowledge, the teacher discussed the concepts of typhoons and provided activities in each concept to support learning. At the same time, the teacher showed some examples of a DIY model house and flood barrier for the students to have an idea about the model they would make. This stage was completed within the first and second days of the learning plan with a total allotted time of 120 minutes.

3.3.4 Decision-Making. The fourth stage focused on the decision-making aspect. After the students acquired sufficient knowledge about the concept and how to make their model, they proceeded to plan and design the model in groups. There are a total of six groups and each group was given a task to conceptualize the design of their model on a long bond paper which served as a blueprint. At last, they presented their blueprint in front of the class. This was accomplished on the fourth day with an allotted time of 60 minutes.

3.3.5 Development of Prototype or Product. The students have executed the design that they planned for their model. The teacher provided the basic materials and allowed the students to add more materials if they wanted to improve their model so long as the materials were cheap, recyclable, and safe to use. The development of the model took at least two days. On the first day, they designed the base of the house including the walls, windows, and door. The next day, they built the roof, flood barrier, and other finishing touches of the model house. The teacher facilitated and guided them along the process and all these activities were accomplished within the fifth and sixth days with an allotted time of 120 minutes.

3.3.6 Test and Evaluation of Solution. In testing and evaluating their model, they simulated the effects of the typhoons, they used a stand fan with attached blue streamers that represented strong winds, and water with debris was poured into the pan to simulate flooding. The students would modify their model if in case it fails to function well, if and only if there is enough time left. The teacher evaluated the model based on the rubric. This was done on the seventh day with an allotted time of 60 minutes.

3.3.7 Completion and Decision Stage. This is the last stage wherein the students present their final output through a gallery display/walk. In the activity, they explained the process of making the model to their classmates, shared what they had learned from the activity, and received input from their peers.

3.4 Expert Validation.

The developed localized STEM lesson was evaluated and rated by STEM experts, and in-service teachers. It utilized the STEM rubric of Tecson (2019).

3.5 Revision

The comments and suggestions of the evaluators were considered in improving the localized STEM-based learning plan on understanding typhoons.

3.6 Data Analysis

Mean was used for the analysis of ratings in the needs assessment questionnaire, and the developed localized STEM-based Learning Plan. For the qualitative part, the responses of the teachers and students in the needs assessment questionnaire were collected and subjected to content and thematic analysis—likewise, a paired sample T-test was used to analyze the significant difference in students' academic performance.

4. Results and Discussions

The needs assessment questionnaire results were the basis for developing the localized STEM-based learning plan for understanding typhoons. This was evaluated by STEM experts, and in-service teachers through a STEM rubric of Tecson (2019).

5. Recommendations

This study demonstrates the effectiveness of integrating music into teaching and learning the concept of chemical bonding. The results unmistakably showcase the positive impact of music integration on student learning outcomes. To enhance the study, the following recommendations are presented:

1. This study was conducted over a short period, it is advisable for future researchers to undertake comprehensive longitudinal studies. These studies would help assess the sustained impact of music integration on student's academic performance over an extended period.
2. Employ diverse instructional approaches by integrating various music genres, styles, and interactive activities into the curriculum to cater to diverse learning preferences.
3. The researchers recommended that gathering continuous feedback from students regarding their experiences with music-integrated learning to optimize its alignment with their learning needs.

4. Encouraging educators to promptly incorporate music integration techniques into their classroom practices, ensuring immediate exposure and benefits for student learning and engagement.

4.1 Needs Assessment of the Science Teachers and Students to Develop a Localized STEM-based Learning Plan.

Five (5) public school science teachers and one section of Grade 8 with an estimated number of 40-43 students were the respondents in a needs assessment. Table 1 provides teachers' responses during the needs assessment. Specifically, it showed the results on the familiarity of teachers with STEM Education and contextualization/localization of a lesson. On the other hand, table 2 presents students' responses about their STEM literacy. This needs assessment questionnaire comprises seven (7) questions regarding students' knowledge of STEM education.

Table 1. Summary of Responses of Science Teachers on STEM Education and Contextualizing/Localizing a Lesson on Understanding Typhoons

Are you familiar with STEM Education and contextualization/localization of lessons?	**NA-ST1: "**Yes, I am familiar with STEM but only as a strand in Senior high school. On the other hand, I am not familiar with the contextualization of lessons." **NA-ST2: "**Yes" **NA-ST3: "**Yes, I am." **NA-ST4: "**Yes. I only know that STEM is a strand in Senior High School. However, I don't know anything about localizing a lesson" **NA-ST5: "**Yes, STEM education is a student-centered approach that enhances students' learning. Contextualization/localization of lessons allows us teachers to provide local examples related to the lesson for students to understand more."
What is your opinion on the integration of a localized STEM learning plan in teaching the topic of typhoons?	**NA-ST1: "**It helps students learn more and we can expect retention of the lesson. **NA-ST2:** "They can depict real-life problems which in the end can create probable solutions. **NA-ST3: "**It can give students an actual conceptualization of the topic as they can relate to the given examples." **NA-ST4: "**Integrating this approach is a powerful way to prepare the learners for a rapidly changing world. **NA-ST5: "**Students are more likely to be engaged and interested. It might also develop their critical thinking skills in solving a problem.

The summary of responses of science teachers on STEM education and contextualizing/localizing a lesson on understanding typhoons is shown in Table 1. The respondents expressed their familiarity with STEM education but only knew it as a strand. Some of them are also familiar with contextualizing/localizing a lesson and others are not. However, they indicated positive opinions on integrating a localized STEM lesson in teaching the said topic. They believed that students could learn more and expect retention of the lesson. Likewise, students will more likely become engaged and interested as it can give actual conceptualization of the lesson provided with examples that they can relate to. It can also depict real-life problems with probable solutions that will develop their critical thinking skills in solving a problem.

The lack of knowledge of science teachers about STEM education is mainly because this framework is not precisely emphasized at the junior level (Tecson, 2019). It was only utilized at the senior high school level in the K-12 curricula. STEM education is viewed more favorably by teachers of higher grade levels (grades 10–12) than by instructors of lower grade levels (grades 7–9) (Hackman et al., 2021). Therefore, there is a need to introduce this teaching approach in the lower years for students to be prepared and for teachers to be acquainted and become more effective during the teaching and learning process. In addition, the K-12 curriculum in our country also highlighted the innovative teaching and learning strategies of localization and contextualization (Bello et al., 2023). To be exact, it was part of the rules and regulations in implementing the enhanced basic education of 2013 which states that the curriculum shall be contextualized and global and shall be flexible enough to enable and allow schools to be localized and indigenous and enhance the quality of education" (Rule II, Curriculum Section, 10.10.2). This approach is necessary for students to be able to connect their experiences and relate their ideas to the topic and to achieve holistic learning.

Table 2. Summary of Responses to Students' STEM Literacy

Statement	Mean	Description
1. I can utilize the concept of science in daily life.	3.50	Strongly Agree
2. I can use the technology in daily life.	3.29	Strongly Agree
3. I can apply scientific and mathematical principles to design something in daily life.	3.62	Strongly Agree
4. I can use mathematics to solve problems in daily life.	3.00	Agree
5. I study science using the STEM (Science, Technology, Engineering, and Mathematics) approach.	1.48	Strongly Disagree
6. Learning with a STEM approach in accordance with the demands of the 21st century.	1.76	Disagree
7. In the 21st century everyone must have critical thinking skills, digital literacy skills, information literacy, media literacy, and master information and communication technology.	3.64	Strongly Agree

Legend: 1.00 – 1.74 – Strongly Disagree 1.75 – 2.49 – Disagree
2.50 – 3.24 – Agree 3.25 – 4.00 – Strongly Agree

Table 2 indicates the summary of responses to students' STEM literacy. This table is comprised of seven questions pertaining to students' knowledge about STEM education. As shown, they strongly agree that they can utilize the concept of science and technology as well as apply scientific and mathematical principles to design something in daily life. They also strongly agree that everyone must acquire necessary and relevant skills in the 21st century. Likewise, they agree on using mathematics to solve problems in daily life. On the contrary, students strongly disagree that they study science using the STEM approach. They also disagree on learning with a STEM approach following the demands of the 21st century. In summary, the student's needs assessment emphasizes that students lack knowledge about STEM education and how it can be used for learning science. This is because science learning in junior high school has not properly integrated STEM literacy since most teachers do not integrate this approach in the classroom which is why students have not been able to apply science, technology, engineering, and mathematics consciously in their daily lives (Nurlaely et al., 2017). Also, most students view each STEM area as a separate subject, and it can be challenging to assess how well students can draw links between various disciplines (Honey et al., 2014). To encourage students to learn in STEM education, the activities should be engaged in a STEM process (Sutaphan & Yuenyong, 2019).

4.2 Validation of the Developed Localized STEM-based Learning Plan on Understanding Typhoons by the STEM Experts, and In-Service Teachers

The developed localized STEM lesson plan was evaluated by three (3) STEM experts and two (2) in-service teachers through the STEM rubric of Tecson (2019). Their comments and suggestions were considered for improving the learning material. The distribution of ratings for each of the adopted STEM rubric criteria is presented in Table 3.

Table 3. Summary of Experts' Rating of the Developed Localized STEM-based Learning Plan in Teaching Typhoons

Components	Mean	Description
Learning Objectives	2.93	Very Good
Learning Content	3.93	Excellent
Degree of Contextualization	3.50	Excellent
STEM Lesson Stages	3.17	Very Good
Overall Rating	3.38	Excellent

Legend: 1.00 – 1.74 – Strongly Disagree 1.75 – 2.49 – Disagree
2.50 – 3.24 – Agree 3.25 – 4.00 – Strongly Agree

The components of rating the developed localized STEM-based learning plan are the learning objectives, learning content, degree of contextualization, and STEM lesson stages. The learning objectives and STEM lesson stages both acquired an average rating of 2.93 and 3.17. These are given a description of "Very Good" in which its mean interval corresponded to values 2.50- 3.24. On the other hand, learning content and degree of contextualization received an average rating of 3.93 and 3.50 respectively which is described as "Excellent" as its mean interval corresponded to values 3.25- 4.00. The overall rating of the components is 3.38 which is indicated as "Excellent". This demonstrates that the developed STEM-based learning plan for teaching typhoons has a guaranteed quality as an instrument in this study. It has been suggested that integrating STEM (Science, Technology, Engineering, and Mathematics) subjects into K–12 projects may increase student interest in these subjects and expand the number of selecting related courses at senior high school and university levels (Honey et al., 2014). However, according to Sutaphan and Yuenyong (2019), STEM education should not simply target students who intend to pursue STEM-related occupations; everyone should be able to interact with the natural and the material setting while possessing a fundamental understanding of STEM-related knowledge, skills, and attitudes.

4.3 Paired Sample T-test Results for the Academic Performance of Grade 8 Students

Group	Df	t-value	p-value
Pretest-Post-test	7.60	-31.648	0.0001

The findings of the paired sample T-test for the academic performance of Grade 8 students during implementation are shown in Table 6. It shows that there is a significant difference between the pre-test and post-test in the academic performance of the students. The data shows a highly significant difference in the achievement scores for the developed lesson in the pre-test and post-test (M = 7.60) conditions; t = -31.648, p <0.0001. This further shows that the students have desirable post-test results using the developed contextualized STEM-based learning plan in teaching typhoons. It only implies that there is an improved understanding of the students in using the developed learning material. According to the study by Kazu & Yalcin (2021), it was understood that STEM education had a significant effect on students' academic success. For this reason, it can be suggested that the application of STEM education should be promoted and encouraged, especially in science classes.

5. Conclusion

In summary, the study showed that science teachers were unfamiliar with STEM education and quite aware of contextualizing/localizing a lesson. Likewise, students lacked knowledge about STEM education and how it can be used for learning science. Therefore, this requires the development of a localized STEM-based learning plan to enhance teachers' understanding of STEM education and contextualization of lessons. At the same time, for students to become more knowledgeable about STEM learning. On the other hand, the development of the localized STEM-based learning plan evaluated by the panel of evaluators had an overall rating of excellent which indicated that the developed learning material offers a guaranteed quality as a learning tool and is ready to be utilized in the classroom. Results also revealed a significant difference in the pretest and post-test in their achievement test which implies that the learning material can improve their performance in learning the topic. Thus, utilizing localized STEM-based learning material is essential to achieve more efficient and sustainable learning experiences while ensuring quality education delivery as it could provide teachers with an innovative strategy in teaching a science concept and for students to experience holistic learning.

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