Development of Localized Context-Based STEM Education Approach Lesson Exemplar on Teaching Science 5

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ABSTRACT

This study utilized an experimental research design, specifically the one-group pre-test and post-test design, to determine the effectiveness of a localized context-based STEM education lesson exemplar in enhancing the conceptual understanding of Grade V learners at Sultan Naga Dimaporo Memorial Integrated School (SNDMIS), Lanao del Norte. Thirty-six (36) Grade V pupils were enrolled during School Year 2025–2026.A 20-item multiple-choice test aligned with the Grade V Science curriculum was administered before and after the intervention. Data were analyzed using frequency and percentage distribution, mean, and the Wilcoxon Signed-Rank Test. Findings showed that pre-test scores were generally low, indicating limited prior understanding of concepts related to the interactions between living and non-living things in estuaries and intertidal zones. After the implementation of the localized STEM lesson exemplar, post-test scores significantly improved. The Wilcoxon test yielded a p-value of 0.000, confirming a significant difference between the pre-test and post-test scores. This result indicates that the localized context-based STEM approach effectively enhanced learners' conceptual understanding.

As part of the intervention, pupils engaged in hands-on STEM activities, including the construction of simple environmental prototypes using recyclable materials. Their outputs were evaluated in terms of creativity, functionality, and use of recycled materials and were scored between 96% and 97%, interpreted as "Outstanding." The study concludes that integrating localized, real-life contexts into STEM instruction improves academic performance, strengthens problem-solving skills, and enhances environmental awareness among learners.

Keywords: Localized Learning, STEM Education, Contextualization, Conceptual Understanding, Lesson Exemplar.

INTRODUCTION

STEM education integrates Science, Technology, Engineering, and Mathematics into a unified approach that emphasizes real-world problem-solving and hands-on learning. Rather than treating these disciplines separately, STEM education highlights their interconnectedness, fostering critical thinking, creativity, collaboration, and innovation. This approach develops learners into confident individuals capable of applying knowledge to real-life situations (International Science Teaching Foundation, 2024).

Science education plays a vital role in developing pupils' critical thinking and understanding of the natural world. However, the Philippines continues to face challenges in student performance. According to findings from the Programme for International Student Assessment (PISA), Filipino students rank among the lowest in Mathematics, Reading, and Science. The 2022 results revealed that less than a quarter of students achieved minimum proficiency levels, with only slight improvement in Science scores compared to 2018 (OECD, 2023).

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These persistent low performance levels highlight the need for innovative teaching strategies. One promising approach is localized, context-based instruction, which connects scientific concepts to learners' real-life experiences. Many learners struggle to relate abstract concepts to their everyday lives, resulting in low engagement and understanding (Ascione, 2022). Studies suggest that integrating culturally relevant and local contexts in instruction improves comprehension and participation (Marosi et al., 2021; Holmes et al., 2021).

Furthermore, integrated STEM education enhances higher-order thinking skills and improves academic outcomes, including motivation and achievement (Le et al., 2023). This aligns with Republic Act No. 10533 (Enhanced Basic Education Act of 2013), which emphasizes contextualized and localized learning approaches.

Despite these findings, limited studies have explored the use of localized context-based STEM lesson exemplars in elementary education, as most research has focused on secondary and higher education levels. Thus, this study aimed to develop and evaluate a localized context-based STEM education lesson exemplar for Grade 5 Science at Sultan Naga Dimaporo Memorial Integrated School, focusing on environmental topics such as estuaries and intertidal zones.

This study contributes to the existing literature by developing and implementing a localized, context-based STEM lesson exemplar specifically designed for Grade 5 Science, focusing on environmental topics such as estuaries and intertidal zones. Unlike previous studies that primarily focus on secondary or general STEM integration, this study provides a concrete classroom-based model that integrates contextualization, hands-on prototype development, and real-life environmental applications within an elementary setting.

Research objective

This study aimed to examine the impact of a localized context-based STEM education lesson exemplar on the academic performance of Grade 5 pupils in Science. Specifically, it sought to determine the respondents' demographic profile in terms of age, gender, and ethnicity; assess students' pre-test scores before the implementation of the intervention; evaluate their post-test scores after the implementation; and examine the overall impact of the localized context-based STEM lesson exemplar on their academic performance in Grade 5 Science.

Hypothesis

The null hypothesis states that there is no significant difference between the pre-test and post-test scores of pupils before and after the implementation of the localized context-based STEM education lesson exemplar.

Theoretical framework

This study is anchored on the principles of Situated Learning Theory, Contextual Learning Theory, and Social Constructivism Theory, which emphasize that learning is most effective when it is contextualized, socially constructed, and grounded in authentic experiences. These theories support the use of localized and context-based approaches in teaching Science, as they promote meaningful learning, active engagement, and the development of higher-order thinking skills.

The findings align with Situated Learning Theory, which posits that learning is enhanced when it occurs in authentic contexts. Through the integration of local environmental examples, pupils were able to relate scientific concepts to real-life situations. Likewise, Contextual Learning Theory explains that learners construct understanding more effectively when new knowledge is connected to prior experiences, which contributed to improved engagement and comprehension among the pupils. Furthermore, Social Constructivism Theory emphasizes the importance of interaction and collaboration in learning, as reflected in the pupils' active participation in hands-on and inquiry-based activities during the lesson implementation.

RESEARCH METHODOLOGY

The study implemented a localized context-based STEM education lesson exemplar designed to make learning more meaningful by connecting Science concepts to the learners' immediate environment, particularly in topics

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related to estuaries and intertidal zones. This approach aimed to enhance pupils' engagement and conceptual understanding through real-life applications and hands-on activities. The study employed a one-group pretest–posttest experimental design to determine the effectiveness of the intervention in improving pupils' academic performance.

The respondents of the study consisted of thirty-six (36) Grade 5 Einstein pupils from Sultan Naga Dimaporo Memorial Integrated School during the academic year 2025–2026. A purposive sampling technique was used, wherein participants were selected based on their enrollment in the identified section and their participation in the Science class where the intervention was implemented.

Data were collected using a 20-item multiple-choice test adapted from a Department of Education (DepEd) Grade 5 Science module, ensuring alignment with the Most Essential Learning Competencies (MELCs) on the topic of interactions between living and non-living things. To ensure content validity, the instrument was reviewed by subject matter experts, including Science teachers, to verify that the items appropriately measured the intended learning objectives. A Table of Specification (TOS) was used to ensure proper distribution of test items across competencies and cognitive levels. The instrument was also examined for clarity and suitability for the learners' level prior to administration.

The collected data were analyzed using both descriptive and inferential statistics, including frequency, percentage distribution, and mean to describe pupils' performance. The Shapiro-Wilk test was used to assess data normality. Since the data did not meet the assumption of normality, the Wilcoxon Signed-Rank Test was applied to determine the significant difference between pre-test and post-test scores. Ethical considerations were observed by securing permission from school authorities and ensuring that participation was voluntary and confidential.

Research findings

Respondent's Demographic Profile

Table 4.1 presents the frequency and percentage distribution of the respondents according to age. The results indicate that among the thirty-six (36) respondents, thirty-three (33) or 91.67% were aged 10 years, two (2) or 5.55% were aged 11 years, and one (1) or 2.78% was aged 9 years.

According to Kos (2024), children aged 8–9 years and 11–12 years tend to develop collaborative patterns of interaction. A localized, context-based STEM education approach promotes such collaboration by encouraging pupils to work together in a student-centered learning environment. This approach enhances communication skills, collaboration, creativity, and critical thinking.

Furthermore, Vygotsky's (1978) Social Constructivist Theory emphasizes that learners develop understanding more effectively when they receive guidance and support from more knowledgeable individuals until they can independently master a concept. In addition, peer learning has been identified as one of the most effective active learning strategies (Hanse, 2022).

Table 4.1 Frequency and Percentage Distribution of the Respondent of the Demographic Profile in terms of Age (n=36).

Age	Frequency	Percentage
11	2	5.55
10	33	91.67
9	1	2.78

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Table 4.2 presents the gender distribution of the respondents. As shown in the table, twenty-two (22) or 61.11% were female, while fourteen (14) or 38.89% were male. This indicates a slightly higher participation of female pupils in the study.

The result suggests that female pupils constituted the majority of participants. This implies that the findings may more strongly reflect the learning responses and engagement of female learners toward the localized context-based STEM education approach.

Several studies have reported no significant gender differences in academic performance. Some have identified slight variations, with boys performing marginally better in mathematics and girls performing slightly better in reading and language-related tasks. However, recent research indicates that such differences are small and have been decreasing over time compared to earlier findings (Educational Psychology literature).

Regardless of gender differences, these should not be considered barriers to learning but rather opportunities to enhance collaboration and skill development among pupils. According to Petty (2025), instead of grouping learners based on ability, mixed-ability grouping is more effective as it encourages collaboration among pupils with varying skill levels.

Table 4.2 Frequency and Percentage Distribution of the Respondent of the Demographic Profile in terms of Gender (n=36).

Gender	**Frequency**	**Percentage**
Male	14	38.89
Female	22	61.11

Table 4.3 presents the ethnicity distribution of the respondents. As shown in the table, twenty-two (22) or 61.11% are Meranaw, thirteen (13) or 36.11% are Cebuano, and one (1) or 2.78% is Maguindanaon. This indicates a higher proportion of Meranaw pupils in the study.The higher representation of Meranaw pupils suggests that their cultural background may have a greater influence on the overall learning interactions observed in the study.

Furthermore, Socio-Cultural Theory by Vygotsky emphasizes that learning occurs through interaction within one's environment, including family, peers, and teachers, and that culture significantly shapes thinking, behavior, and learning processes (Yusof, 2021). In this regard, aligning instructional materials with learners' cultural backgrounds is essential to ensure relevance and meaningful learning experiences.

Table 4.3 Frequency and Percentage Distribution of the Respondent of the Demographic Profile in terms of Ethnicity (n=36).

Ethnicity	**Frequency**	**Percentage**
Cebuano	13	36.11
Meranaw	22	61.11
Maguindanaon	1	2.78

Pretest and Posttest Gain Scores of the Respondents

The results show a clear improvement in pupils' performance after the intervention. In the pre-test, most pupils (58.33%) were classified as "Fairly Achieved," while some (25.00%) were "Not Achieved," indicating limited prior understanding of the science concepts. However, in the post-test, a majority of pupils (69.44%) reached the "Highly Achieved" level, while the remaining (30.55%) were "Moderately Achieved," with no pupils falling under the lower categories. This shift demonstrates that the localized context-based STEM education approach

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effectively enhanced pupils' conceptual understanding and engagement by connecting lessons to real-life experiences. This finding supports Melvin (2022), who emphasized that when learners establish strong connections between their knowledge and real-world contexts, they become more engaged and motivated to learn. Similarly, Holmes et al. (2021) found that localized STEM instruction improves academic performance and deepens students' interest in Science.

Table 4.4 Frequency and Percentage Distribution of Respondents' score in Pre-test and Post-test (n=36).

Score	**Pre-Test**		**Post-Test**		**Interpretation**
	f	%	f	%	
16-20	2	5.56	25	69.44	Highly Achieved
11-15	4	11.11	11	30.55	Moderately Achieved
6-10	21	58.33	0	0	Fairly Achieved
1-5	9	25	0	0	Not Achieved

The line graph below presents the pre-test and post-test scores of the respondents. The blue line represents the pre-test frequencies, while the orange line represents the post-test frequencies. The graph clearly illustrates the improvement in pupils' scores, showing a noticeable difference between their performance before and after the intervention.

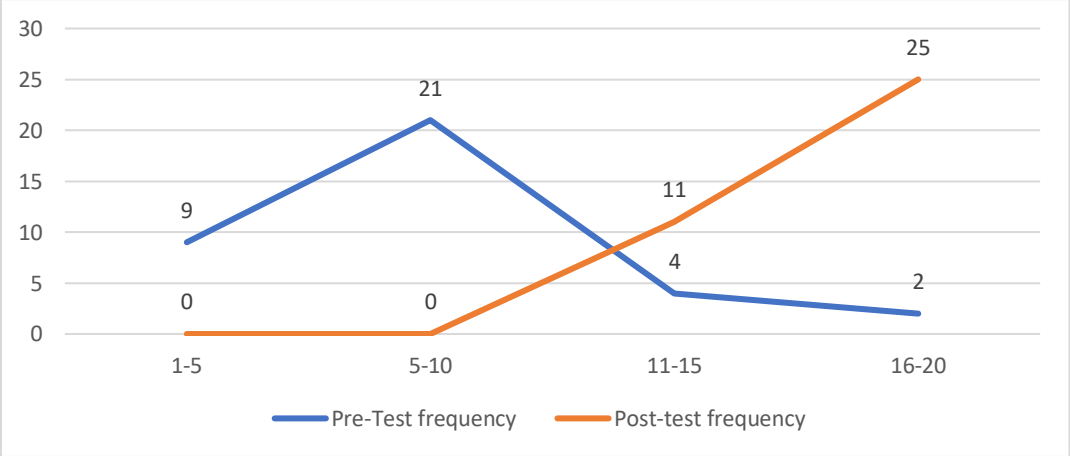

Figure. 4.1 Line Graph of Pre-test and Post-test Scores of the Respondents

Significant Difference of Pre-test and Post-Test Scores of the Respondents

Table 4.5 presents the results of the Wilcoxon Signed Rank Test, which was employed to examine the difference between the pre-test and post-test scores of Grade 5 pupils following the implementation of the localized, context-based STEM education approach in Science. The test resulted in a p-value of 0.000, which is less than 0.05 level of significance. Hence, the null hypothesis of no significant difference between the pre-test and post-test scores is rejected. This finding indicated that pupils obtained significantly higher scores in the post-test than in the pre-test, demonstrating that the localized, context-based STEM education approach had a positive impact on their learning outcomes in Science.

This finding was further supported by Montero and Geducos (2022), whose study demonstrated improved conceptual understanding in learning biology through localized and contextualized learning activities shows that pupils exposed to a localized context-based approach performed better that the control group exposed to the traditional approach. Therefore, it implies that the teaching-learning process becomes more effective when the

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lessons are related to pupils' prior knowledge and experiences, making them appreciate their culture as they grasp knowledge from it.

Table 4.5 Significant difference between the respondents' pre-test and post-test Score (n=36).

p-value	Level of significant	Decision
*0.000	0.05	Ho rejected

*Note: ** significant at 0.05 level*

Evaluation Results of Garbage Collectors Prototype

The prototypes developed by the Grade 5 pupils were evaluated by a panel of ten (10) judges with relevant background in Science and environmental education. A structured rubric was used, consisting of three criteria: creativity and design (30%), functionality (40%), and environmental purpose (30%), each with clearly defined performance indicators. Prior to evaluation, the judges were oriented on the use of the rubric to ensure consistent understanding of the criteria. Each judge independently evaluated the prototypes to avoid bias. The scores from all judges were compared and averaged to obtain the final rating for each group. Inter-rater reliability was addressed through the consistency of scores across judges, indicating a reasonable level of agreement in the evaluation process. This evaluation provided evidence of pupils' ability to apply scientific concepts in practical contexts, demonstrating creativity, problem-solving skills, and environmental awareness.

Group 1

Figure 4.12 Group 1 Prototype: Trash Bin

Group 2

Figure 4.13 Group 2 Prototype: Push Dust Bin

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Group 3

Figure 4.14 Group 3 Prototype: Garbage Net

Group 1 earned 96 points in creativity and design, 97 in functionality, and 98 in environmental purpose, for a total of 291 points or 97%. Group 2 earned 95 points in creativity and design, 97 in functionality, and 97 in environmental purpose, totaling 289 points or 96.33%. Group 3 earned 96 points in creativity and design, 96 in functionality, and 96 in environmental purpose, with a total of 288 points or 96%.

These results helped identify the strengths and areas for improvement of each group. Overall, Group 1 achieved the highest score, while Group 2 led Group 3 by a single point. In conclusion, the use of this rubric encouraged pupils to grow, innovate, and further improve their work.

Table 4.6 Evaluation Results of Garbage Collectors Prototype.

Group	Percentage	Description	Verbal Interpretation
Group 1	97.00%	Excellent	Outstanding
Group 2	96.33%	Excellent	Outstanding
Group 3	96.00%	Excellent	Outstanding

DISCUSSION

The findings of this study demonstrate that the implementation of the localized context-based STEM education lesson exemplar significantly improved the academic performance of Grade 5 pupils in Science. While the pre-test results indicated that most pupils had only a basic or limited understanding of concepts—evidenced by their classification under “Fairly Achieved” and “Not Achieved”—the post-test results showed a clear shift toward higher levels of achievement. However, beyond describing this improvement, it is important to examine why the intervention was effective.

One key factor contributing to the improvement is the use of contextualized learning, where lessons were anchored in pupils’ real-life environment, particularly estuaries and intertidal zones. When learners are able to relate abstract scientific concepts to familiar situations, cognitive connections become stronger, making it easier for them to construct meaning. This supports existing educational theories which emphasize that learning

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becomes more effective when new knowledge is built upon prior experiences. In this study, the localized context served as a bridge between theoretical content and practical understanding, explaining the observed increase in performance.

Another contributing factor is the integration of hands-on and inquiry-based STEM activities, which actively engaged pupils in the learning process. Unlike traditional lecture-based instruction, the STEM approach encouraged exploration, experimentation, and problem-solving. This active involvement likely enhanced both conceptual understanding and retention. The significant result from the Wilcoxon Signed-Rank Test confirms that the improvement was not incidental but can be attributed to the intervention. This aligns with prior studies in STEM education, which report that experiential and student-centered strategies lead to higher academic achievement compared to passive learning methods.

Moreover, the collaborative nature of the activities played a crucial role in improving learning outcomes. Through group tasks and prototype development, pupils were able to exchange ideas, clarify misconceptions, and co-construct knowledge. Social interaction in learning environments has been widely recognized in educational research as a factor that enhances understanding and critical thinking. In this context, collaboration not only supported academic performance but also promoted communication and teamwork skills.

The development and evaluation of prototypes further illustrate that pupils were able to transfer their knowledge into practical applications. This indicates deeper learning, as students moved beyond memorization to application and analysis. Such outcomes are consistent with broader STEM education goals, which emphasize the development of 21st-century skills such as creativity, critical thinking, and problem-solving. The success of this component suggests that localized STEM activities can effectively bridge the gap between knowledge acquisition and real-world application.

In comparison with broader literature, the findings of this study reinforce previous research highlighting the effectiveness of contextualized and localized teaching approaches in improving student engagement and achievement. However, this study contributes specifically by demonstrating how a localized, context-based STEM lesson exemplar can be applied in a Grade 5 Science setting focused on environmental topics. This adds to the growing body of evidence that integrating local context into STEM education is particularly beneficial in making learning more meaningful and relevant for learners.

While previous studies have explored contextualized and STEM-based instruction, this study extends existing literature by demonstrating how a localized lesson exemplar can be effectively implemented at the elementary level. Specifically, it highlights the integration of environmental context with hands-on prototype development, allowing learners to apply scientific concepts in meaningful ways. This provides a practical model for teachers seeking to contextualize STEM instruction in similar settings.

Overall, the effectiveness of the intervention can be attributed to the combined impact of contextualization, active learning, collaboration, and real-world application. These elements worked together to create a learning environment that not only improved academic performance but also fostered essential skills. Therefore, the localized context-based STEM education lesson exemplar is not merely an alternative teaching strategy but a meaningful and evidence-based approach to enhancing Science education.

CONCLUSION

Based on the findings of this study, the following conclusions are drawn: The results revealed that the majority of the respondents were female, Meranaw, and 10 years old. Despite these demographic characteristics, the study found that they did not significantly influence the pupils' learning in Science. This suggests that the intervention applied in the study was effective regardless of gender, ethnicity, or age, highlighting its suitability for diverse learners. Furthermore, it can be concluded that the pupils' performance in Science improved significantly when using the localized, context-based STEM education approach. The post-test results show that twenty-five (25) out of thirty-six (36) pupils achieved outstanding scores, and no pupil received a low score. This indicates a clear difference in performance between the pre-test and post-test, demonstrating that the approach effectively enhanced the pupils' learning outcomes in Science. Moreover, the analysis of the respondents' pre-test and post-

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test scores indicated a significant improvement in their performance. The increase in scores from pre-test to post-test demonstrates that the teaching strategies and learning activities employed in the study had a positive impact on the pupils' understanding 66 and mastery of Science concepts. This improvement reflects not only the effectiveness of the instructional materials and methods but also the pupils' engagement and active participation in the learning process. The study also confirmed that developing a localized context-based STEM education approach is an effective method that teachers can use in their instruction. Based on the researchers' observations, the pupils enjoyed learning and engaging in activities using this approach, which contributed to a more meaningful learning experience. This study offers a practical and replicable model of a localized, context-based STEM lesson exemplar that can be utilized by elementary Science teachers to enhance both conceptual understanding and real-world application of learning.

Suggestion

Based on the findings of the study, it is recommended that the localized context-based STEM education approach be continuously used in teaching Science, especially in topics that can be easily connected to learners' real-life environment. Since the results showed improvement in pupils' performance after the intervention, teachers may adopt this approach to make lessons more meaningful and easier for learners to understand. It is also suggested that teachers be encouraged to design more contextualized and activity-based lessons that involve hands-on tasks and real-life applications to further enhance pupils' engagement and participation.

In addition, schools may support teachers by providing training, materials, and resources needed to effectively implement localized STEM activities in the classroom. This can help ensure that the approach is applied properly and consistently. Future classroom practices may also include more opportunities for pupils to explore ideas independently, ask questions, and reflect on their learning, as this can help strengthen their critical thinking and problem-solving skills.

Moreover, the development of pupils' outputs such as prototypes may be improved by giving more time for planning, testing, and revising their work. This will allow learners to be more creative and produce more functional outputs. Lastly, future researchers may conduct similar studies using a larger group of participants or a longer duration of implementation to further examine the effectiveness of the localized context-based STEM education approach in improving academic performance and promoting deeper understanding in Science.

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