

PILOT TEST: IMPLEMENTATION OF THE LOCALIZED CONTEXT-BASED STEM EDUCATION APPROACH ON SELECT BIOLOGY TOPICS

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ABSTRACT

This study designed and implemented a localized context-based STEM education approach to enhance Grade 3 students understanding of selected Biology topics, particularly Things in the Surroundings and Our Local Ecosystem. There were 70 Grade 3 students chosen as respondents of the study using the purposive sampling technique. Anchored in Sustainable Development Goals 4 (Quality Education), the pilot program was conducted at Sultan Naga Dimaporo, and integrated with local environmental and cultural contexts into the curriculum to promote meaningful, inquiry-driven learning. Utilizing a mixed-methods design, data were gathered through observations, prototype evaluations, formative assessments, pretest–posttest achievement tests, and student reflections. Results revealed significant improvements in students' conceptual understanding and performance, as evidenced by a highly significant difference ($p = 0.000$) between pretest and posttest scores. Qualitative findings indicated increased engagement and environmental awareness, with students demonstrating the ability to relate scientific concepts to real-world situations. The approach proved feasible, culturally relevant, and effective in fostering active participation and higher-order thinking among young students. The study underscores the value of integrating localized knowledge and community resources into STEM education, aligning instruction with students lived experiences. Future directions emphasize expanding the program's implementation and providing teacher training to sustain contextualized STEM instruction across grade levels and disciplines.

Keywords: Localized learning; Context-based STEM; Biology education; Environmental awareness; Conceptual understanding; Curriculum innovation

1. Introduction

The effectiveness of learning hinges significantly on the alignment of instructional materials and teaching methods with the specific needs and contexts of students. Research shows that contextualized learning approaches, which incorporate students' local realities and experiences, can significantly improve learning outcomes (Rivet & Krajcik, 2007; Johnson, 2012). This emphasis on relevant, inclusive, and learner-centered instruction underscores the study's essential contribution to SDG 4: Quality Education, which advocates for equitable and high-quality learning opportunities for all. However, science educators often face challenges in designing tailored instructional approaches due to constraints such as large class sizes, classroom management difficulties, and limited instructional resources (Moluayonge & Park, 2017). These barriers limit the ability of teachers to fully engage students in meaningful science learning experiences (Hodson, 2003). Localized context-based learning, which emphasizes the integration of local knowledge and experiences into the curriculum, offers significant benefits in enhancing student engagement and fostering culturally relevant learning (Ladson-Billings, 1995; Sutaphan and Yuenyong, 2019). This approach enhances the relevance of educational content, making it more meaningful and applicable to students' lives (Wortham, 2006). By connecting learning to students' immediate environments, context-based learning promotes deeper understanding and increased motivation (Anderson et al., 2001). The integration of STEM (science, technology, engineering, and mathematics) approaches further strengthens this framework by fostering critical thinking, problem-solving, and practical skills crucial for addressing real-world challenges (National Research Council, 2012). Integrating STEM into biology education equips students with the tools to analyze complex systems, design solutions, and apply their knowledge to solve problems within their communities (Bybee, 2013). However, a significant gap exists in the literature regarding the effective integration of localized context-based STEM approaches across various biology-related subject areas.

While research supports the individual benefits of context-based learning and STEM education, a comprehensive framework for their synergistic integration within biology curricula remains largely unexplored. By exploring the integration of a localized context-based STEM approach in select biology topics across various subject areas, focusing on the development of a robust educator training program. STEM education, while valuable, needs to move beyond abstract concepts and engage students through hands-on experiences and real-world applications (National Research Council, 2012). Localized context-based learning, which emphasizes relevance and cultural sensitivity, enhances engagement and deeper understanding (Sutaphan and Yuenyong, 2019). This approach, drawing inspiration from the principles of culturally relevant pedagogy (Ladson-Billings, 1995), recognizes the importance of incorporating local knowledge and perspectives to make learning more meaningful and impactful. The rationale for integrating STEM approaches into biology education is clear: it fosters the development of critical thinking, problem-solving, and practical skills essential for addressing complex environmental challenges (OECD, 2016).

In the Philippines, STEM education is crucial for addressing everyday challenges, enhancing quality of life, and promoting economic growth. Despite government initiatives, the country faces declining student numbers in Science programs, low scores in international assessments (TIMSS and PISA), and a shortage of STEM teachers (Malipot, 2022; Pimthong and Williams, 2018). The latest reports from the Programme for International Student Assessment (PISA) and World Bank rank the Philippines among the countries struggling the most with basic literacy, numeracy, and STEM delivery.

The pilot test was conducted with a group of Grade 3 students from Sultan Naga Dimaporo. The primary objective was to assess the feasibility and effectiveness of the localized context-based STEM learning program. The curriculum was designed around two key lessons: 'Things in the Surroundings' and 'Our Local Ecosystem.' These lessons incorporated local examples, real-world problems, and community resources to make the learning experience relevant and engaging.

2. Research objective

The pilot test for the localized context-based STEM learning program aimed to achieve the following objectives: assess the program's feasibility by determining whether the curriculum and activities were practical and achievable within the given timeframe and available resources, evaluate the program's effectiveness by gathering preliminary data on students pretest-posttest results and their ability to apply those concepts to local contexts and to identify areas for improvement by gaining insights into which aspects of the program required adjustments or further development before full-scale implementation. This approach ensured that the pilot test provided valuable information for refining the program and maximizing its impact on students' learning.

3. Hypothesis

This study put forward that there is a significant difference between the pretest and posttest scores of the students.

4. Theoretical framework

A research framework for implementing localized STEM education was grounded in several learning theories. Constructivism supports connecting biological concepts to students' local environments, facilitating knowledge construction through experience. Situated Learning Theory emphasizes that learning is context-dependent, suggesting that localized curricula enhance learning by situating it within students' community and culture. Meaningful Learning Theory posits that relating new knowledge to existing knowledge makes learning more effective, supporting the use of local contexts to connect biological concepts to students' prior experiences (Ausubel, 1968). Furthermore, Social Cognitive Theory highlights the role of observational learning and social experiences, suggesting that students learn by observing real-

world applications of STEM concepts in their communities (Bandura, 1977). Lastly, the STEM Education Framework (National Research Council, 2012). This framework highlights the integration of STEM subjects, emphasis on problem-solving, and promotion of STEM literacy. Integration of STEM subjects is crucial for effective STEM education. Problem-solving and STEM literacy are essential components of STEM education.

These theoretical frameworks presented provided a strong foundation for a localized, context-based STEM approach. By focusing on real-world, local problems, students engage in active, interdisciplinary learning that is both meaningful and relevant to their lives, fostering deeper understanding and a meaningful learning.

5. Research methodology

The curriculum implemented in the pilot test was intentionally designed to be localized, aiming to enhance learner engagement and relevance by grounding instruction in students' immediate environmental and cultural contexts. Localized curriculum design involves the deliberate inclusion of local knowledge, resources, and real-life issues, enabling students to see the direct applicability of their learning. This approach also fosters a stronger connection between the school and the community, and aligns with constructivist pedagogies that emphasize meaningful learning experiences.

The study employed experimental one-group pretest and posttest design with qualitative support in gathering the data. Data collected were done through formative assessments, prototype evaluations, and feedback from students, teachers, and community members.

Moreover, purposive sampling technique was used to select the respondents of the pilot testing. These respondents were chosen through purposive sampling technique were members of the samples predefined by the criterion which the Grade 3 pupils in one of the integrated schools in Sultan Naga Dimaporo.

Additionally, data analysis combined qualitative and quantitative techniques. To gain respondents' approval in answering the survey questionnaire, informed consent was also included in the questionnaire. Informed consent is one of the founding principles of research ethics. This was intended to determine if the respondents of the study took part in the research freely and voluntarily. Participants were free to ask questions and withdraw at any time without consequence, ensuring the protection of their rights and privacy.

The questionnaire's results were examined, researched, analyzed, and appraised. The responses of the chosen respondents to the open-ended question posed during the focus group discussion held with the respondents who had been interviewed were examined using thematic analysis. Quantitative data from rubric ratings and pretest–posttest scores were analyzed using the Wilcoxon Signed-Rank Test.

6. Research findings

During the development of the prototype, the students created projects according to their group. The Science group created waste material collage, the Technology group created a poster, the Engineering group created the DIY trash bin while the Mathematics group created the Graph on the numbers of Object they found in the Surroundings.

Prior to the development of the prototype students were asked to do a nature walk and take an observation on the garbage that they saw on the walkway of the school. As they observed, they also have collected it and sorted it accordingly. After sorting it out, the collected garbage on the walkway of the school was used on making their prototypes.

6.1 Quality of Output of the Students on the Developed Prototype for the Lesson Things in the Surroundings

Table 1 Ratings of the evaluators to the prototype of the Science Group

Waste Material Collage	CRITERIA					Total	Description
	Applicability of the Product	Layout/ Design	Creativity	Presentation	Collaboration		
	25%	15%	20%	25%	15%		
Group 1	4	4	4	4	4	4.00	Advanced
Group 2	4	3	3	3	3	3.25	Proficient

Legend: 3.26-4.00 Advanced (A), 2.51-3.25 Proficient (P), 1.76-2.50 Needs Improvement (NI), 1.00-1.75 Failed (F)

The evaluation of the Science group's prototype shows a range of performance. Group 1 obtained an advanced rating (4.00), indicating that their output was highly applicable, well-presented, and creatively designed. In contrast, Group 2 scored at the proficient level (3.25), suggesting that while they were able to meet the expected outcomes, their work lacked refinement in terms of layout and creativity. This disparity reflects that students were able to apply scientific concepts effectively, but the execution varied depending on group dynamics and effort. According to Johnson and Johnson (2009), collaboration significantly influences the quality of group outcomes, as effective cooperation fosters greater engagement and innovation. The results suggest that while the Science group demonstrated strong content applicability, greater emphasis on creativity and design could further enhance their work.

Students recognized issues found in the environment and draw conclusions regarding these environmental conditions. Based on their findings, students made on a STEM-related projects that aligns with their observations, incorporating scientific investigation, technological documentation, engineering problem-solving, or mathematical analysis. These projects allowed students to apply their knowledge in real-world contexts, fostering creativity and problem-solving skills. Below are the created prototypes of the students.

(A) Group 1



(B) Group 2



Figure 1: Output of the Science Group (Pilot Test)

The Science group made collage out from the garbage they collected outside during the nature walk. This only shows that students have the ability to transform waste materials into creative output. This implies that if students will be given opportunity to interact with their environment, through this they may realize that even waste materials can be made into something new as one of the advocacies of STEM education.

Table 2: Ratings of the evaluators to the prototype of the Technology Group

POSTER	CRITERIA					Total	Description
	Content	Layout/ Design	Creativity	Presentation	Collaboration		
	25%	15%	20%	25%	15%		
Group 1	3	4	3	4	4	3.55	Advanced
Group 2	3	3	3	4	3	3.25	Proficient

Legend: 3.26-4.00 *Advanced (A)*, 2.51-3.25 *Proficient (P)*, 1.76-2.50 *Needs Improvement (NI)*, 1.00-1.75 *Failed (F)*

For the Technology group, the poster-making activity encouraged both content mastery and design application. Group 1 received an advanced rating (3.55), showcasing strong performance in layout, presentation, and collaboration, while Group 2 scored proficient (3.25), reflecting a need for more innovation in creativity and design. This outcome highlights the importance of integrating visual literacy and creativity in technology-related tasks. Trilling and Fadel (2009) emphasize that 21st-century learning requires not only knowledge application but also creativity and communication skills to effectively express ideas. The evaluators' ratings imply that while students were competent in presenting information, they still need to develop originality and more innovative approaches in their technological outputs.

(A) Group 1



(B) Group 2

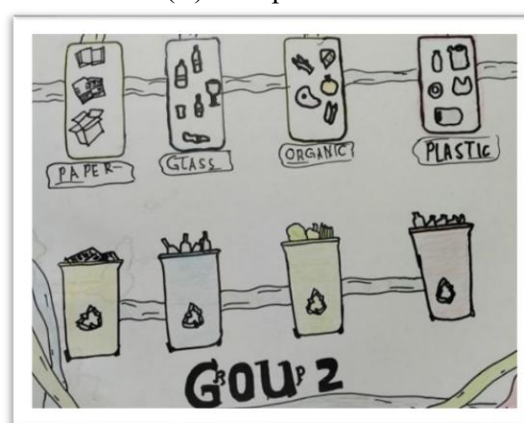


Figure 2: Output (Poster) of the Technology Group (Pilot Test)

The technology group were asked to make posters on how to properly throw and segregate garbage. Their output was the product of their imagination, as they emphasized on how to properly segregate garbage in the community. By doing this, it only shows that though they are still young they already have the ability

to be creative and concern with their environment. This only shows that through STEM education approach students' ability to discern on how to protect the environment in their own simple way.

Table 2: Ratings of the evaluators to the prototype of the Engineering Group

DIY Plastic Trash bin	CRITERIA					Total	Description
	Content	Layout/ Design	Creativity	Presentatio n	Collaborati on		
	25%	15%	20%	25%	15%		
Group 1	3	3	3	4	4	3.40	Advanced
Group 2	4	4	4	4	4	4.00	Advanced

Legend: 3.26-4.00 Advanced (A), 2.51-3.25 Proficient (P), 1.76-2.50 Needs Improvement (NI), 1.00-1.75 Failed (F)

The Engineering group produced some of the highest-rated outputs, with Group 1 achieving an advanced rating (3.40) and Group 2 receiving a perfect score of 4.00 (Advanced). This reflects that the prototype was not only practical and functional but also creatively executed and well-presented. The high ratings suggest that engineering-related tasks, being hands-on and problem-solving in nature, encouraged students to maximize their potential and apply knowledge in real-life contexts. Kolb (2015) supports this through his theory of experiential learning, which emphasizes that students learn best when actively engaged in creating solutions to real-world problems. Thus, the engineering project fostered both critical thinking and creativity, resulting in consistently advanced-level outputs.

(A) Group 1



(B) Group 2



Figure 3: Output (DIY Trash bin) of the Engineering Group (Pilot Test)

For the engineering group, students were tasked to make a trash can from bottles. This activity made them realize that plastics which seems to be waste can turn into something useful. As they do their activity, students' creativity and critical thinking skills was developed. This can be said that the localized

STEM education approach had helped students critical thinking skills developed as they explored possibilities in making the waste one into something new and useful.

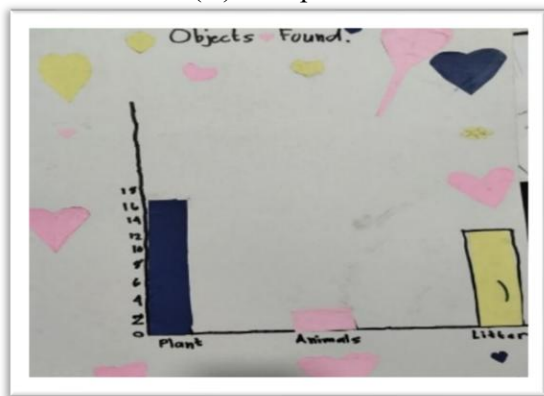
Table 4: Ratings of the evaluators to the prototype of the Mathematics Group

Let's Graph It!	CRITERIA					Total	Description
	Content	Layout/ Design	Creativity	Presentation	Collaboration		
	25%	15%	20%	25%	15%		
Group 1	4	4	3	4	4	3.80	Advanced
Group 2	4	4	3	4	3	3.65	Advanced

Legend: 3.26-4.00 *Advanced (A)*, 2.51-3.25 *Proficient (P)*, 1.76-2.50 *Needs Improvement (NI)*, 1.00-1.75 *Failed (F)*

The Mathematics group consistently achieved advanced ratings, with Group 1 scoring 3.80 and Group 2 at 3.65. These results indicate strong performance in collaboration, presentation, and content application, though creativity received slightly lower ratings compared to other criteria. This suggests that students focus heavily on accuracy and correctness of the task, with less emphasis on innovative or artistic elements. As noted by Trilling and Fadel (2009), mathematical learning in the 21st century should integrate both critical thinking and creativity to prepare students for complex problem-solving. The evaluators' ratings affirm that the Mathematics group successfully applied content knowledge and worked collaboratively, but further encouragement is needed to help them incorporate creativity into their mathematical outputs.

(A) Group 1



(B) Group 2



Figure 4: Output (Let's Graph it!) of the Mathematics Group (Pilot Test)

6.2 Output of the Students on the topic Relate the importance of surroundings to people and other living things

To deepen their understanding, students reflect on the difference between habitat and ecosystem and participate in group research activities where they identify local plants and animals, determine their survival needs, and propose ways to help them thrive, often summarized in a chart. The project then

transitions into an interactive role-play through “STEM Superheroes,” where students form teams—the Science Squad, Technology Titans, Engineering Experts, and Mathematics Masters—to design missions for saving the environment. Each team applies STEM skills in creative tasks: building a mini-ecosystem in a jar, crafting a nature web, designing simple habitats, and creating maps of the natural environment. Altogether, the project not only strengthens students’ scientific knowledge but also fosters creativity, collaboration, and problem-solving, making STEM learning more relevant, engaging, and connected to local community contexts.

Table 5: Ratings of the evaluators to the prototype of the Science Squad

Mini Ecosystem in a Jar (Aquarium)	CRITERIA					Total	Description
	Content	Layout/ Design	Creativity	Presentation	Collaboration		
	25%	15%	20%	25%	15%		
Group 1	4	3	4	3	4	3.60	Proficient
Group 2	3	3	3	3	3	3.00	Proficient

Legend: 3.26-4.00 *Advanced (A)*, 2.51-3.25 *Proficient (P)*, 1.76-2.50 *Needs Improvement (NI)*, 1.00-1.75 *Failed (F)*

The Science Squad received proficient ratings for both groups, with Group 1 scoring 3.60 and Group 2 obtaining 3.00. The evaluators noted that the outputs demonstrated clear content understanding, particularly in representing ecological concepts, but there were limitations in layout and presentation that prevented them from achieving an advanced level. This indicates that while students grasped the scientific principles behind ecosystems, they struggled to translate this knowledge into a more creative and visually engaging product. According to Johnson and Johnson (2009), collaboration enhances learning outcomes, but effective teamwork must also include innovation and critical thinking to achieve higher performance. The results highlight that the Science Squad effectively met the task requirements but require further development in presentation and design to elevate their outputs.

(A) Group 1



(B) Group 2



Figure 5: Output (DIY Mini Ecosystem in a Jar (Aquarium) of the Science Squad (Pilot Test)

The Science Squad project focused on building a Mini Ecosystem in a Jar (Aquarium), where students design a small-scale environment with plants and possibly tiny fishes. This activity allows students to see firsthand how living things interact and depend on each other for survival. By observing the role of sunlight, water, and air in sustaining life, they gain a deeper understanding of ecological relationships. The project encourages inquiry-based learning, as students explore the balance within an ecosystem while nurturing responsibility for caring for living organisms.

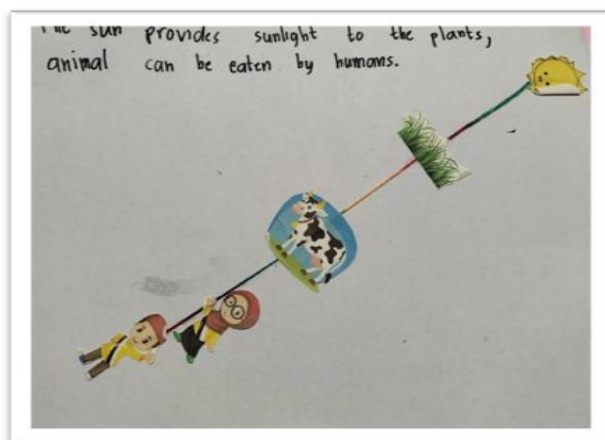
Table 6: Ratings of the evaluators to the prototype of the Technology Titans

Nature Web	CRITERIA					Total	Description
	Content	Layout/Design	Creativity	Presentation	Collaboration		
	25%	15%	20%	25%	15%		
Group 1	3	3	3	4	4	3.40	Proficient
Group 2	4	4	4	4	4	4.00	Advanced

Legend: 3.26-4.00 Advanced (A), 2.51-3.25 Proficient (P), 1.76-2.50 Needs Improvement (NI), 1.00-1.75 Failed (F)

The Technology Titans demonstrated varied performance across the two groups. Group 1 earned a proficient rating (3.40), reflecting competency in presentation and collaboration but moderate performance in creativity and layout. Group 2, on the other hand, achieved a perfect advanced rating (4.00), excelling in all criteria including content, creativity, and design. This contrast shows how technology-based tasks allow students to demonstrate both communication skills and innovative thinking when effectively executed. As Trilling and Fadel (2009) argue, 21st-century learning involves the integration of creativity, collaboration, and communication to present ideas effectively. The evaluators' ratings affirm that when students actively apply these skills, they are capable of producing advanced-level outputs in technology-based projects.

Group 1



(B) Group 2

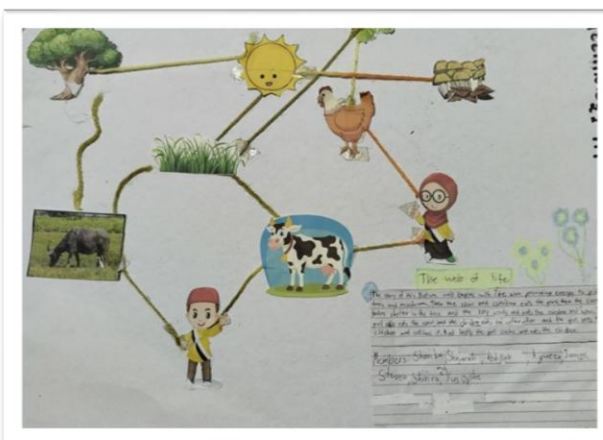


Figure 6: Output (Nature Web) of the Technology Titans (Pilot Test)

The Technology Titans project engages students in Creating a Nature Web Using Crafts, where they use materials such as yarn, string, and pictures to illustrate food chains and food webs. Through this creative and hands-on activity, students demonstrate how plants, animals, and humans are interconnected in their environment. By visualizing relationships—like how a spider depends on flies, and flies depend on plants—students develop a clearer picture of how ecosystems function. This project highlights the importance of technology in representing and communicating scientific ideas in an accessible and artistic way. Furthermore, students were asked to create a story on the connections they have made, to show their ability to integrate English subject while learning other discipline.

Table 7: Ratings of the evaluators to the prototype of the Engineering Builders

Building a Simple Animal Habitat (Bird's Nest)	CRITERIA					Total	Description
	Content	Layout/ Design	Creativity	Presentation	Collaboration		
	25%	15%	20%	25%	15%		
Group 1	4	4	4	3	4	3.75	Advanced
Group 2	3	3	3	3	4	3.15	Proficient

Legend: 3.26-4.00 *Advanced (A)*, 2.51-3.25 *Proficient (P)*, 1.76-2.50 *Needs Improvement (NI)*, 1.00-1.75 *Failed (F)*

The Engineering Builders' prototypes reflected a combination of advanced and proficient performance. Group 1 scored 3.75 (Advanced), with strengths in content, creativity, and collaboration, although presentation was slightly weaker. Meanwhile, Group 2 obtained 3.15 (Proficient), showing that while the task was accomplished, it lacked refinement in creativity and design. These results highlight the potential of hands-on engineering activities to engage students in problem-solving and innovation. Kolb (2015) emphasizes that experiential learning allows students to apply knowledge in authentic contexts, which was evident in the more advanced performance of Group 1. However, the difference between the two groups also suggests the need for consistent scaffolding to help all students reach a higher level of execution.

(A) Group 1



(B) Group 2



Figure 11: Output (Simple Animal Habitat) of the Engineering Builders (Pilot Test)

The Engineering Experts project emphasizes Building a Simple Animal or Plant Habitat, allowing students to become designers and builders of a safe living space for small organisms. By constructing habitats such as a bug hotel or a plant house, students apply engineering principles while considering essential survival needs like food, water, shelter, and protection. This project fosters creativity, critical thinking, and problem-solving as students evaluate whether their design can sustain the organism's life. It also raises awareness of how human intervention can positively or negatively affect habitats in the real world.

Table 9: Ratings of the evaluators to the prototype of the Mathematics Masters

Nature Map Using Shapes	CRITERIA					Total	Description
	Content	Layout/ Design	Creativity	Presentation	Collaboration		
	25%	15%	20%	25%	15%		
Group 1	4	4	4	4	4	4.00	Advanced
Group 2	3	3	3	3	3	3.00	Proficient

Legend: 3.26-4.00 Advanced (A), 2.51-3.25 Proficient (P), 1.76-2.50 Needs Improvement (NI), 1.00-1.75 Failed (F)

The Mathematics Masters showed a wide performance gap between the two groups. Group 1 excelled with a perfect advanced rating (4.00), demonstrating mastery in content, layout, creativity, and collaboration. In contrast, Group 2 received a proficient score of 3.00, indicating that while they met the task requirements, their output lacked innovation and depth. These findings suggest that mathematical tasks can be transformed into more engaging and creative outputs when students are encouraged to move beyond procedural accuracy. As Trilling and Fadel (2009) note, creativity and critical thinking are essential skills even in structured disciplines like mathematics, as they allow students to connect abstract ideas with meaningful applications. The evaluators' feedback highlights that integrating creativity into mathematics activities enhances both understanding and presentation quality.

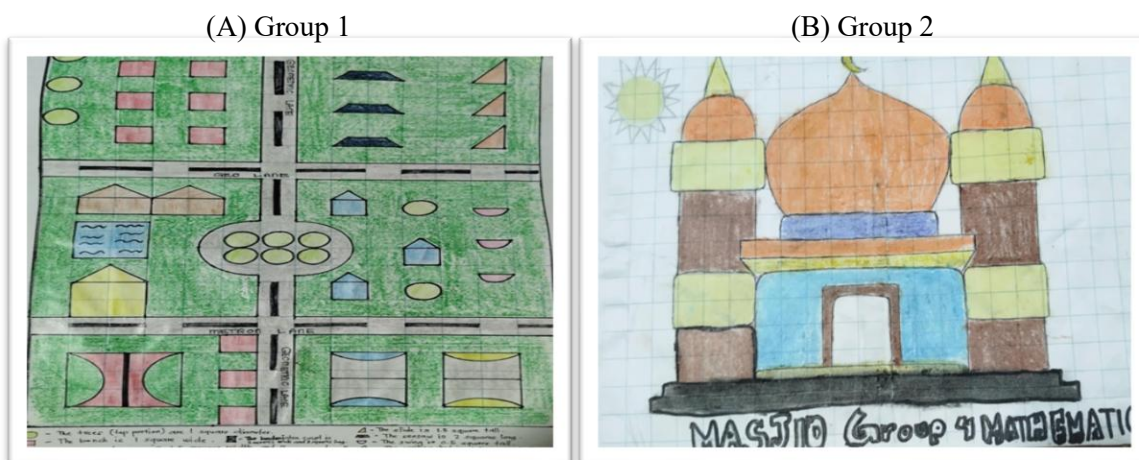


Figure 10: Output (Simple Nature Map Using Shapes) of the Mathematics Masters (Pilot Test)

The Mathematics Masters project introduces students to Creating a Simple Nature Map Using Shapes, where they act as explorers and mapmakers. By observing their surroundings and recording features of the natural environment, students use mathematical concepts such as measurement, shapes, and spatial representation. They may map out trees, plants, or small water sources using circles, squares, and other geometric figures. This activity not only strengthens mathematical skills but also builds appreciation for how math can describe and organize the natural world. It combines exploration with precision, showing that math is a powerful tool in understanding and protecting the environment.

6.3 Performance of the students in the Pretest and Posttest

Figure 11 presents the result of the pretest and posttest of the Grade 3 students. It can be gleaned that in the pretest the majority of the students' acquired scores between 8-11 and 12-15 scores respectively. However, in the posttest, the learners scores are within the range 20-23 and 24-27, respectively. This means that the students have positive improvement from pretest to posttest. Furthermore, this implies that there is a conceptual gain among respondents on the topics discussed to them using the localized context-based STEM education approach. These findings provide evidence that using contextualized materials significantly improved learners conceptual understanding as supported by the findings of Barrun and Cajurao (2025) that contextualized learning materials significantly improve students' conceptual understanding, science process skills, and attitudes toward science.

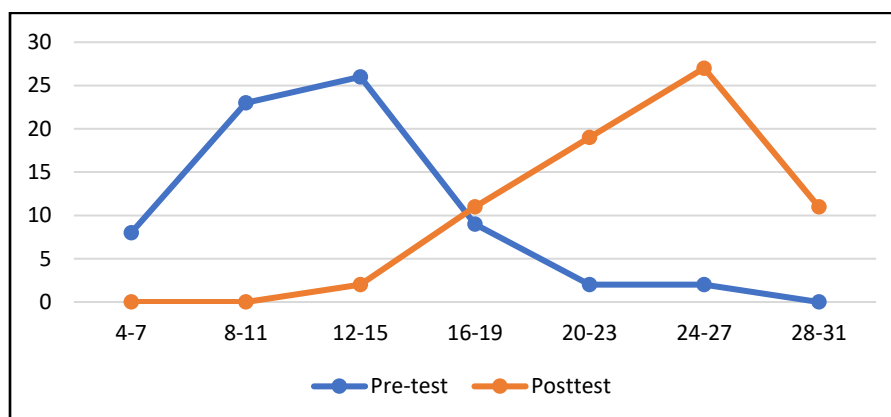


Figure 11: Students Scores in the Pretest and Posttest (Pilot Test)

Comparison on the learner's performance in the pretest and posttest

Data on the pretest and posttest scores of the respondents undergone normality test to determine if the score are normally distributed or the other way around which is not normally distributed. Results showed that data are not normally distributed thus it is recommended that non-parametric test will be used to test the difference between the pretest and posttest. Hence the Wilcoxon Signed Rank Test was used to determine the significant difference between the pretest and the posttest scores of the students. The results showed that the computed p-value of 0.000 is less than 0.05 level of significance, thus, the null hypothesis is rejected. This means that there is a significant difference between the pretest and the posttest scores of the students and the performance of the students in the posttest is significantly better than the pretest.

Table 11: Comparison between pretest and posttest of the students

p-value	Level of significance	Decision
0.000*	0.05	Ho Rejected

*highly significant at $\alpha=0.05$

Ho: There is no significant between the pretest and the posttest scores of the students.

7. Discussion

The first week of implementing the localized context-based STEM education approach which was focused on guiding Grade 3 students in exploring and understanding their surroundings through structured inquiry-based activities. The lesson began with an introductory discussion where students described their environment, identify social issues, and propose potential solutions. This activity enhanced their observational and critical thinking skills while fostering environmental awareness. Following this, students was engaged in guided exploration by working in groups to map specific areas of their school, systematically document their observations, and categorize elements in their surroundings, such as plants, animals, man-made objects, and natural features. The data collected was analyzed, allowing students to recognize patterns and draw conclusions regarding environmental conditions. Based on their findings, students collaborated on a STEM-related project that aligns with their observations, incorporating scientific investigation, technological documentation, engineering problem-solving, or mathematical analysis. These projects allowed students to apply their knowledge in real-world contexts, fostering creativity and problem-solving skills. The week was concluded with student presentations, peer assessments, and reflective discussions on their learning experiences, emphasizing the importance of maintaining a clean and safe environment. By integrating hands-on activities, collaborative learning, and data-driven inquiry, the implementation of this lesson ensures that students develop a deeper appreciation of their surroundings while strengthening their STEM competencies in a meaningful and engaging manner.

In the second week of implementing the localized context-based STEM education approach, students explored the importance of their surroundings to people and other living organisms through interactive, inquiry-based activities. The lesson commenced with a nature walk, allowing students to observe their environment and identify both healthy and unhealthy aspects, fostering awareness of environmental conditions. Through guided discussions, students analyzed the interactions between living organisms and their surroundings, using visual aids to enhance their understanding. Research questions were driven deeper exploration, prompting students to investigate the needs of plants and animals, the effects of pollution, and ways to support ecological balance. In the decision-making stage, students will engage in a creative "STEM Superhero" activity, forming teams to address an environmental issue using scientific inquiry, technology, engineering solutions, and mathematical data representation. This collaborative approach not only reinforces STEM concepts but also enhances problem-solving and teamwork skills. The development phase was focused on executing their projects, with each group applying their chosen STEM discipline to propose solutions such as environmental monitoring, educational posters, prototype designs, and data visualization. The week was concluded with a "Superhero Mission Briefing & Awards Ceremony," where students presented their findings and solutions, foster communication skills and reinforcing the significance of environmental stewardship. By integrating observation, research, problem-solving, and creative expression, this week-long lesson equipped students with a deeper appreciation of ecological interdependence while promoting active participation in environmental conservation.

Two exemplar lessons, "Things in the Surroundings" and "Relate the importance of surroundings to people and other living things," illustrate this localization strategy. The former lesson engaged students in identifying and categorizing natural and man-made objects within their environment, fostering observational skills while introducing basic ecological concepts. The latter lesson extended this by examining local flora and fauna, promoting ecological literacy through the exploration of biodiversity specific to the students' surroundings. Both lessons utilized local examples, such as nearby rivers, indigenous plant species, or traditional farming practices, and incorporated community resources like local parks or environmental workers as guest speakers or knowledge sources.

The activities employed in the pilot test were designed to be highly interactive, inquiry-driven, and experiential, aligning with best practices in learner-centered pedagogies. These activities not only facilitated conceptual understanding but also nurtured critical thinking, collaboration, and creativity among students.

Nature Walks served as a foundational activity, allowing students to directly engage with their local environment. During these walks, students were tasked with observing natural elements, documenting biodiversity, and noting human impact on their ecosystem. This immersive experience promoted scientific inquiry skills such as observation, data collection, and hypothesizing, while also grounding ecological concepts in lived experience.

Group Activities emphasized collaborative learning, where students worked in teams to process and synthesize information. These included brainstorming sessions to identify environmental issues, sorting and categorizing field observations using charts or graphic organizers, and designing solutions to local problems such as waste management or water conservation. Through these collective tasks, students developed communication and problem-solving skills, reinforcing the social dimensions of learning.

STEM-Focused Projects were integral to the curriculum's application phase, allowing students to integrate knowledge from science, technology, engineering, and mathematics. For example, students may have designed water filtration systems using local materials or created models of local food chains. These projects emphasized the practical application of interdisciplinary knowledge, encouraging students to innovate and apply their learning to address real-world environmental challenges within their community.

The pilot testing of the localized context-based STEM education approach for Grade 3 students showed positive outcomes in terms of learning, engagement, and application of concepts to real-world contexts. Students created prototypes such as waste material collages, posters, DIY trash bins, and graphical representations of data. Evaluations revealed varying performance across groups: engineering and mathematics projects consistently achieved advanced ratings, while science and technology outputs ranged from proficient to advanced, reflecting differences in creativity, design, and collaboration. The second set of activities, including mini-ecosystems, nature webs, simple habitats, and nature maps, also demonstrated students' understanding of ecological concepts. While some groups excelled in creativity and presentation, others remained at the proficient level, showing the need for further scaffolding in innovation and design. Quantitative results showed significant improvement in posttest scores compared to pretest results, confirmed through the Wilcoxon Signed-Rank Test ($p = 0.000 < 0.05$). This indicates that the approach substantially enhanced conceptual understanding, science process skills, and positive attitudes toward science. Learner reflections highlighted increased awareness of environmental issues, appreciation for hands-on activities like nature walks and prototype-making, and enjoyment of active learning roles such as reporting. These experiences fostered creativity, critical thinking, and responsibility toward environmental stewardship. The study confirmed the feasibility and effectiveness of the localized STEM approach. It improved student engagement, collaboration, and performance, emphasizing the importance of integrating local contexts, interactive activities, and inquiry-driven strategies in science education.

8. Conclusion

After the development phase, designing and implementing of the localized context-based STEM lesson exemplar on select Biology topics was done. The pilot testing of the localized context-based STEM education approach for Grade 3 students showed positive outcomes in terms of learning, engagement, and application of concepts to real-world contexts. Students created prototypes such as waste material collages, posters, DIY trash bins, and graphical representations of data. Evaluations revealed varying performance across groups: engineering and mathematics projects consistently achieved advanced ratings, while science and technology outputs ranged from proficient to advanced, reflecting differences in creativity, design, and collaboration. The second set of activities, including mini-ecosystems, nature webs, simple habitats, and nature maps, also demonstrated students' understanding of ecological concepts. While some groups excelled in creativity and presentation, others remained at the proficient level, showing the need for further scaffolding in innovation and design. Quantitative results showed significant improvement in posttest scores compared to pretest results, confirmed through the Wilcoxon Signed-Rank Test ($p = 0.000 < 0.05$).

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9. Suggestion

Building upon the positive outcomes of the pilot testing, future research was focused now on expanding the implementation of localized context-based STEM education to larger and more diverse student populations across different grade levels. However, before the classroom implementation was done, a training program on integrating localized context-based STEM education approach on select Biology topics across subject areas (Freeman et al., 2014). Additionally, exploring cross-disciplinary integration such as combining STEM with local cultural practices, environmental issues, and indigenous knowledge could further contextualize learning and strengthen students' connection to their communities (Aikenhead & Elliott, 2010).

Another important direction is the professional development of pre-service and in-service teachers. Training programs should be designed to enhance teachers' capacity in creating localized curricula, adopting inquiry-based strategies, and using authentic assessment tools that measure higher-order thinking skills (Darling-Hammond et al., 2020). This holistic perspective would provide a stronger evidence base for policymakers and curriculum developers to institutionalize localized STEM education at the national level (Bybee, 2013).

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