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Integrating Clean and Green Initiatives into Chemistry and Physical Science Instruction: A Qualitative Case Study of Teaching Practices of a Teacher

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Abstract

Sustainability education has become an essential component of science teaching as schools respond to global environmental challenges and the need to develop environmentally responsible learners. This qualitative case study examined how Clean and Green initiatives were integrated into Chemistry and Physical Science instruction by a secondary school teacher. Anchored in constructivist learning theory and education for sustainable development (ESD) frameworks, the study explored pedagogical strategies that linked scientific concepts to environmental practices and real-life contexts. Data were collected through semi-structured interviews, lesson plan analysis, instructional materials review, and documentation of Clean and Green activities, and were analyzed using thematic analysis. Findings revealed that environmental contextualization enhanced conceptual understanding, learner engagement, and interdisciplinary connections. Teaching practices were characterized by experiential learning, inquiry-based activities, and reflective pedagogy that linked science content with environmental responsibility. Despite challenges related to time constraints and resource limitations, teacher agency and adaptability enabled the sustained integration of sustainability initiatives into science instruction. The study concludes that Clean and Green initiatives can serve as effective pedagogical resources in Chemistry and Physical Science when supported by reflective teaching and institutional support.

Keywords: science education, sustainability pedagogy, Clean and Green initiatives, chemistry instruction, qualitative case study

1. Introduction

Mathematics education plays a critical role in developing learners' problem-solving skills, logical reasoning, and capacity to apply knowledge to real-life situations. These competencies are essential not only for academic success but also for everyday decision-making and lifelong learning. However, mathematics is frequently perceived by learners as abstract, difficult, and disconnected from their daily experiences, a perception that is particularly evident in rural school contexts. In such settings, limited access to varied instructional materials, technological resources, and enrichment opportunities can further reinforce the notion that mathematics is a set of isolated rules and procedures rather than a practical and meaningful discipline. Addressing this challenge requires teaching approaches that deliberately situate mathematical concepts within familiar, authentic, and culturally relevant contexts that resonate with learners' lived experiences.

Within the Philippine basic education system, contextualization is strongly promoted as a core pedagogical principle, especially in rural, coastal, and geographically isolated communities. Curriculum policies emphasize the use of local contexts, community practices, and indigenous knowledge as instructional resources to make learning more meaningful and responsive to learners' environments. One such context is the *Gulayan sa Paaralan* program, a school-based gardening initiative designed to promote food security, environmental sustainability, and practical life skills among learners. Through activities such as planting, measuring, harvesting, and record-keeping, the program provides authentic experiences that can be linked to various academic subjects, including mathematics.

Although *Gulayan sa Paaralan* is primarily implemented as a sustainability, nutrition, and environmental education program, it offers rich opportunities for interdisciplinary and contextualized learning. Mathematical concepts such as measurement, data representation, ratio, and basic operations can be naturally embedded in gardening activities, allowing learners to see the relevance of mathematics in real-life tasks. Such integration aligns with constructivist and experiential learning theories, which emphasize learning through active engagement and meaningful experiences. However, despite this pedagogical potential, there is limited empirical research examining how school-based programs like *Gulayan sa Paaralan* are intentionally integrated into mathematics teaching practices, particularly in rural secondary school settings.

This study addresses this gap by exploring the contextualized teaching practices of a Teacher II in Mathematics at Dipaculao National School, Aurora, Philippines. By examining how *Gulayan sa Paaralan* and other local contexts are used as instructional resources, the study seeks to provide insights into how contextualized pedagogy can enhance Mathematics.

2. Review of Related Literature

Contextualized teaching and learning is grounded in constructivist learning theory, which posits that learners actively construct knowledge through meaningful interaction with their social, cultural, and physical environments rather than through passive reception of information (Vygotsky, 1978). In this view, learning becomes more effective when new concepts are connected to learners' prior knowledge and everyday experiences. Empirical studies support this perspective, demonstrating that contextualized instruction enhances comprehension, retention, and transfer of learning by linking abstract concepts to real-life situations that are familiar and relevant to learners (Berns & Erickson, 2001; Johnson, 2002). By situating academic content within authentic contexts, teachers are able to make learning more meaningful and accessible, particularly for learners who struggle with decontextualized and abstract instruction.

In the field of mathematics education, the importance of contextualized and experiential approaches is particularly evident in rural school settings. Research on rural mathematics education highlights that learners in these contexts often come from diverse cultural and socioeconomic backgrounds, which shape how they perceive and engage with mathematical concepts (Azano & Stewart, 2016). Localized instructional approaches that draw on community practices, daily activities, and familiar environments have been shown to increase learner motivation and participation. Boaler (2016) emphasizes that context-based mathematics instruction allows learners to see mathematics as a useful and relevant tool for understanding and solving real-world problems, thereby improving conceptual understanding and reducing anxiety associated with the subject. Such approaches are especially valuable in rural schools where traditional textbook-based instruction may not fully address learners' needs and experiences.

School-based programs also serve as valuable pedagogical resources for contextualized and interdisciplinary learning. Initiatives such as school gardening programs provide authentic, hands-on contexts that naturally integrate multiple subject areas, including mathematics, science, and environmental education. Research suggests that incorporating these programs into academic instruction promotes experiential learning by allowing learners to apply theoretical concepts to practical tasks, thereby strengthening the connection between theory and practice (Blair, 2009). Similarly, Williams and Dixon (2013) found that garden-based learning experiences positively influence learners' academic outcomes by fostering engagement, collaboration, and deeper understanding. These findings underscore the pedagogical potential of school-based programs as instructional resources, particularly in

rural contexts where experiential and context-rich learning opportunities can enhance the relevance and effectiveness of classroom instruction.

3. Methodology

This study employed a qualitative case study research design to explore teaching practices within a real-life school context. The case study approach was appropriate because it allowed for an in-depth and holistic examination of instructional strategies and contextualized pedagogy as they were naturally enacted in the mathematics classroom. By focusing on a single case, the study was able to capture the complexities of teaching practice, teacher decision-making, and the use of local contexts in mathematics instruction.

The research was conducted at Dipaculao National School located in Barangay Mucdol, Dipaculao, Aurora, Philippines. The primary participant was a Teacher II handling Mathematics who was actively involved in implementing contextualized instructional practices through the integration of school-based programs, particularly the *Gulayan sa Paaralan*. The participant's direct engagement in both classroom instruction and school initiatives provided rich and relevant insights into how contextualized pedagogy was planned and enacted in a rural school setting.

Data were collected using multiple qualitative sources to ensure depth and triangulation. Semi-structured interviews with the Teacher II were conducted to elicit detailed accounts of instructional strategies, experiences, and reflections related to contextualized mathematics teaching. In addition, lesson plans and instructional materials were analyzed to examine how mathematical concepts were contextualized in planned classroom activities. Documents related to the *Gulayan sa Paaralan* program were also reviewed to understand how the program was utilized as a pedagogical resource and aligned with mathematics instruction.

Data analysis followed a thematic analysis process involving systematic coding, categorization, and theme development. Patterns and meanings were identified across interview transcripts and documentary data to generate coherent themes that described contextualized teaching practices. To enhance credibility and analytical rigor, triangulation was employed by comparing findings across multiple data sources, allowing for well-supported interpretations of the teaching practices examined in the study.

4. Results and Findings

Analysis of the data yielded four major themes describing teaching practices in mathematics instruction.

Theme 1: Contextualized Mathematics through Real-Life Applications

The teaching practices emphasized the use of real-life situations drawn from the school's *Gulayan sa Paaralan* program to make mathematical concepts more concrete and meaningful. Abstract topics such as measurement, ratio, basic operations, and data representation were embedded in everyday gardening tasks, enabling learners to see the relevance of mathematics in familiar contexts.

Participant Responses:

One participant explained, "*Mas naiintindihan ng mga bata ang sukat at bilang kapag ginagamit namin ang taniman bilang halimbawa.*" Another noted, "*Nagiging konkreto ang math kapag nakikita nila ito sa araw-araw at hindi lang sa libro.*" A third response added, "*Mas mabilis nilang naiuugnay ang lesson kapag may aktwal na sitwasyon na pinanggagalingan.*"

These responses indicate that contextualized instruction supported learners' conceptual understanding by bridging abstract mathematical ideas with real-world experiences. This finding aligns with contextual learning theory, which posits that learning is enhanced when academic content is connected to learners' everyday environments and experiences (Johnson, 2002; Berns & Erickson, 2001). Such approaches are particularly effective in rural settings, where local contexts provide rich instructional resources.

Theme 2: Experiential and Hands-On Learning

Experiential and hands-on activities were central to mathematics instruction, allowing learners to actively engage with mathematical concepts through direct manipulation and observation. Activities such as measuring plant growth, counting harvest yields, and recording garden data enabled learners to learn by doing rather than through passive listening.

The participant shared, "*Mas aktibo ang mga bata kapag sila mismo ang gumagawa at sumusukat.*" Another response stated, "*Kapag may aktwal na gawain, mas tumatagal ang pag-unawa nila sa lesson.*" A third noted, "*Mas nagiging interesado ang mga mag-aaral kapag may galaw at aktibidad.*"

These findings demonstrate that experiential learning promoted both cognitive and behavioral engagement by involving learners physically and mentally in the learning process. This supports Kolb's (1984) experiential learning theory, which emphasizes that knowledge is constructed through concrete experience and reflection. Hands-on learning has been shown to enhance understanding and retention, especially in mathematics instruction where abstract concepts benefit from tangible experiences.

Theme 3: Interdisciplinary Integration

Mathematics instruction was integrated with other subject areas such as science, health, and environmental education through the gardening program. Lessons were designed to connect numerical skills with scientific observation, nutrition concepts, and environmental awareness, fostering a holistic learning experience.

The participant explained, "*Napag-uugnay namin ang Math, Science, at Edukasyon sa Kalusugan sa Gulayan.*" Another response noted, "*Hindi hiwalay ang Math; kasama ito sa pag-aaral ng halaman at kalusugan.*" A third added, "*Mas nakikita ng bata na magkakaugnay ang mga asignatura.*"

This interdisciplinary approach supported holistic learning by allowing learners to apply mathematical knowledge across multiple domains. Consistent with Drake and Burns (2004), interdisciplinary instruction promotes deeper understanding by demonstrating how concepts intersect across subject areas. Such integration is particularly beneficial in rural schools, where maximizing learning opportunities through connected instruction enhances relevance and efficiency.

Theme 4: Adaptive Teaching amid Contextual Challenges

Despite the pedagogical benefits of contextualized and experiential instruction, the participant identified challenges related to limited instructional time, availability of materials, and competing school responsibilities. These constraints required flexibility and continuous adjustment in lesson planning and implementation.

One response stated, "*Kailangan talagang maging flexible dahil hindi laging sapat ang oras at kagamitan.*" Another shared, "*May mga pagkakataon na ina-adjust ko ang activity depende sa sitwasyon.*" A third noted, "*Hindi lahat ng plano ay natutupad, kaya mahalaga ang pag-aangkop.*"

These responses highlight the importance of teacher adaptability and reflective practice in sustaining meaningful instruction under challenging conditions. This finding aligns with research on rural education, which emphasizes that effective teaching in rural contexts requires resilience, flexibility, and strong pedagogical commitment (Azano & Stewart, 2016). The ability to adapt instructional strategies ensured the continuity and effectiveness of contextualized mathematics teaching despite structural limitations.

5. Discussion

The findings demonstrate that contextualized teaching practices significantly enhance mathematics instruction by transforming abstract concepts into accessible and meaningful learning experiences for students. By situating mathematical ideas within familiar and practical contexts, learners were able to better understand and apply concepts such as measurement, number sense, and data interpretation. This approach reduced the perceived difficulty of mathematics and encouraged active participation, as learners could directly observe the relevance of mathematical knowledge in real-life situations. Such findings reinforce the value of contextualized instruction in addressing common challenges in mathematics education, particularly in rural settings where traditional, textbook-driven approaches may fail to fully engage learners.

The integration of *Gulayan sa Paaralan* into mathematics lessons further supported experiential and interdisciplinary learning by providing authentic tasks that naturally linked mathematics with science, health, and environmental education. Gardening activities allowed learners to engage in hands-on measurement, data collection, and problem-solving, thereby strengthening conceptual understanding through experience and application. This finding is consistent with prior studies on context-based pedagogy, which highlight that meaningful contexts and experiential learning opportunities enhance learner motivation and deepen understanding (Boaler, 2016; Blair, 2009). By connecting mathematics to school-based programs, instruction became more holistic and relevant, fostering connections across subject areas.

Central to the successful implementation of these practices was the role of teacher agency and reflective practice. The Teacher II demonstrated the ability to adapt lessons, reflect on learner responses, and creatively utilize available resources to sustain contextualized instruction despite limitations in time and materials. This underscores the importance of teacher autonomy and professional judgment in rural school contexts, where instructional innovation often depends on teachers' capacity to respond flexibly to contextual constraints. Collectively, the findings highlight that contextualized teaching practices, when supported by reflective and proactive teacher agency, can be effectively sustained and can significantly improve the quality of mathematics instruction in rural schools.

6. Conclusion

This study provides evidence that contextualized teaching practices can effectively support mathematics learning in rural secondary schools by making instruction more relevant, engaging, and meaningful for learners. By leveraging school-based programs such as *Gulayan sa Paaralan* as instructional resources, teachers were able to connect mathematical concepts to authentic, real-life situations, thereby enhancing learner engagement and

strengthening conceptual understanding. These practices allowed learners to see mathematics as a practical tool for solving everyday problems rather than as an abstract subject confined to the classroom. However, to maximize the impact of contextualized pedagogy, sustained institutional support is essential. This includes providing teachers with adequate time, resources, and professional development opportunities to design, implement, and refine context-based instructional strategies that respond to the realities of rural education settings.

7. Implications and Recommendations

Teachers are encouraged to intentionally integrate real-life contexts and school-based programs into mathematics instruction to make learning more meaningful and relevant for learners. By drawing on familiar experiences, community practices, and programs such as *Gulayan sa Paaralan*, teachers can help learners connect abstract mathematical concepts to practical applications, thereby increasing engagement, motivation, and conceptual understanding. Such integration also supports experiential and interdisciplinary learning, allowing students to apply mathematics in authentic situations that mirror real-world problem-solving.

School leaders play a crucial role in sustaining contextualized pedagogy and should therefore provide continuous professional development that focuses on contextualized and interdisciplinary teaching approaches. Training programs should equip teachers with practical strategies for designing context-based lessons, integrating school programs into academic instruction, and adapting pedagogy to local realities. In addition, school leaders should create supportive structures such as collaborative planning time and instructional mentoring that encourage innovation and reflective practice among teachers.

For future research, scholars may employ multiple case study designs or mixed-methods approaches to generate broader and more generalizable evidence on the effectiveness of contextualized pedagogy. Combining qualitative insights with quantitative measures of learner achievement can provide a more comprehensive understanding of how context-based teaching influences academic performance, engagement, and long-term learning outcomes, particularly in rural education settings.

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