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Enhancing Grade 12 Students' Science Process Skills through a Culturally Responsive Instructional Framework in Physics

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ABSTRACT

This study examined the level of performance of Grade 12 students in various science process skills—observing, classifying, measuring, communicating, inferring, predicting, defining operationally, formulating hypotheses, interpreting data, controlling variables, and experimenting—using a culturally contextualized instructional framework in Physics at Tuburan National High School. The research focused on students' pretest and posttest scores in competencies related to applying the relationship R=VIR = \{V}{I}R=IV (Ohm's Law) and solving related problems, while also exploring how contextualized and meaningful learning experiences may influence their engagement and skill development. Seventy students participated in the study through a descriptive design employing a questionnaire technique. Statistical tools such as weighted mean, chi-square, coefficient of contingency, and t-test were used to analyze the data. Findings revealed that students initially demonstrated a "Needs Improvement" level in both Ohm's Law competencies. However, significant gains were observed in their posttest scores after the implementation of the instructional framework. Beyond academic improvement, the integration of familiar cultural contexts and community-based examples made Physics more accessible and relevant to learners, supporting their development as confident and critical thinkers. The results highlight the potential of culturally responsive instructional practices not only to strengthen science process skills but also to promote equitable participation and meaningful learning in Physics classrooms. The study recommends the continued use and expansion of this instructional framework in Grade 12 Physics classes at Tuburan National High School.

Keywords: Instructional Framework, Physics Education, Science Process Skills, Grade 12, Culturally Responsive Teaching

INTRODUCTION

Science education plays a crucial role in developing scientifically literate citizens capable of reasoning, problem-solving, and making responsible decisions in daily life. Science process skills (SPS)—including observing, measuring, classifying, predicting, inferring, interpreting data, and experimenting—are fundamental to this development (Rillero, 2008). In the Philippine K to 12 curriculum, SPS are emphasized as essential competencies for preparing learners to engage meaningfully with science and society.

At Tuburan National High School, students often perceive experimental exercises as burdensome, resulting in limited acquisition of SPS. Observations revealed frequent errors in laboratory outputs, primarily attributed to insufficient development of these skills. This challenge underscores the need for instructional approaches that not only develop SPS but also connect scientific learning to students' lived realities, local contexts, and cultural experiences.

Recent educational reforms advocate for culturally responsive and contextualized teaching to promote equity, engagement, and deeper conceptual understanding. Such approaches recognize that students bring diverse cultural

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backgrounds, prior experiences, and ways of knowing that, when integrated into instruction, enrich learning and foster meaningful participation. By situating Physics lessons in familiar environments and community practices, students are more likely to engage actively, apply skills effectively, and develop a stronger understanding of scientific concepts.

This study aimed to:

1. Assess the pretest and posttest performance of senior high school students in SPS.
2. Develop and implement an instructional framework for teaching Physics that enhances SPS through contextualized and culturally relevant activities.
3. Determine the effectiveness of the framework in improving student performance, promoting scientific literacy, and empowering learners within the broader social and educational context.

LITERATURE REVIEW

Educational and Policy Context

The 1987 Constitution of the Philippines mandates accessible, quality education and underscores the importance of science and technology for national development (Art. XIV, Sec. 1 & 10). The Enhanced Basic Education Act of 2013 (K-12) further emphasizes inquiry-based learning and the development of science process skills (SPS) as essential for preparing learners with 21st-century competencies (DepEd, 2016). Within this policy framework, science education is expected to not only improve academic performance but also cultivate socially responsible, scientifically literate citizens capable of contributing to community development.

Science Process Skills in Education

SPS—including observing, measuring, classifying, predicting, experimenting, inferring, interpreting data, and problem-solving—are strongly associated with improved academic achievement, critical thinking, and scientific reasoning. Local studies reveal that Filipino learners often exhibit moderate levels of SPS due to limited instructional support, abstract learning materials, and minimal integration of cultural or contextualized examples in classrooms (Salmeron, 2023; Tomas, 2023). Instructional approaches such as inquiry-based learning, project-based learning, and flipped classrooms have been shown to significantly enhance SPS by actively engaging students in meaningful, context-rich tasks (Tan, Yangco, & Que, 2020; Reyes, 2023; Tejero, 2025).

Theoretical Framework

This study is grounded in Gagné's hierarchy of intellectual skills, which emphasizes structured progression from foundational knowledge to higher-order cognitive competencies (Driscoll, 2004). Effective Physics instruction requires mastery of both basic and integrated SPS, enabling students to independently analyze, experiment, and apply scientific concepts. By embedding instruction within familiar, culturally relevant contexts, the framework aligns with constructivist and culturally responsive pedagogical principles, which enhance engagement, skill acquisition, and learner empowerment.

METHODOLOGY

Research Design

A descriptive research design with a pretest-posttest evaluation was employed. The study also integrates elements of action research, implementing SPS-focused instructional strategies in Physics to actively improve students' skills while examining their effectiveness in real classroom contexts.

Participants

Seventy Grade 12 students from Tuburan National High School participated in the study. The sample included learners from diverse cultural and socio-economic backgrounds, reflecting the school's community demographics.

Instruments

SPS Test: Competency 1 (Ohm's Law application), Competency 2 (problem-solving with current, voltage, resistance).

Questionnaire: Measured students' SPS performance and attitudes toward Physics experiments, including engagement with contextualized, culturally relevant activities.

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Data Analysis

Weighted mean for descriptive interpretation
Chi-square test for association of variables
Coefficient of contingency for strength of association
t-test to determine significant differences between pretest and posttest scores

RESULTS AND DISCUSSION

Pretest Performance

Competency 1: Using R=V/IR=V/IR=V/I

Scores	Frequency	Percentage	Verbal Description
23	0	0	Outstanding
21–22	0	0	Above Average
18–20	2	2.86	Average
15–17	15	21.43	Below Average
≤14	53	75.71	Needs Improvement

Competency 2: Solving Ohm's Law Problems

Scores	Frequency	Percentage	Verbal Description
17	0	0	Outstanding
15–16	0	0	Above Average
13–14	1	1.43	Average
11–12	4	5.71	Below Average
≤10	65	92.86	Needs Improvement

Posttest Performance

Competency 1: Using R=V/IR=V/IR=V/I

Scores	Frequency	Percentage	Verbal Description
23	8	11.43	Outstanding
21–22	29	41.43	Above Average
18–20	28	40.00	Average
15–17	3	4.29	Below Average
≤14	2	2.86	Needs Improvement

Competency 2: Solving Ohm's Law Problems

Scores	Frequency	Percentage	Verbal Description
17	17	24.29	Outstanding
15–16	34	48.57	Above Average
13–14	14	20.00	Average
11–12	4	5.71	Below Average
≤10	1	1.43	Needs Improvement

Statistical Analysis

Competency 1: $t = -22.16$, $p < 0.01$ (highly significant)
Competency 2: $t = 26.34$, $p < 0.01$ (highly significant)

The results demonstrate significant improvement in both competencies after implementing the instructional framework. Beyond academic gains, students engaged more actively in Physics, connecting concepts to local and cultural contexts. This suggests that culturally responsive instruction can enhance SPS, promote critical thinking, and empower learners to apply science meaningfully in their daily lives and communities.

CONCLUSION

Pretest results revealed low performance in both SPS competencies, whereas posttest results showed substantial improvement. The culturally responsive instructional framework significantly enhanced students' abilities in applying and solving Ohm's Law problems. Furthermore, integrating contextualized and culturally relevant examples contributed to meaningful engagement, skill acquisition, and the development of critical

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thinking. The findings highlight the potential of culturally grounded instructional strategies to promote both academic success and broader social and educational development.

RECOMMENDATION

It is recommended that the proposed instructional framework be implemented in Grade 12 Physics classes to enhance students' science process skills. Teachers should receive training in inquiry-based instruction, the integration of SPS, and culturally responsive teaching strategies to ensure effective facilitation of learning. Lessons should incorporate locally available materials and community-based examples for hands-on experimentation, making learning more engaging, meaningful, and contextually relevant. Additionally, fostering a learning environment that encourages both collaborative and independent activities can further develop students' critical thinking, problem-solving abilities, and overall learner empowerment. Finally, further research is encouraged to investigate the long-term effects of culturally responsive Physics instruction on students' scientific literacy, engagement, and social development.

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