Enhancing Science Learning for Diverse Learners at Iligan City National School of Fisheries: An Action Research Study

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DOI: https://doi.org/10.51244/IJRSI.2026.13010196

Received: 24 January 2026; Accepted: 02 February 2026; Published: 16 February 2026

ABSTRACT

This action research investigated the effectiveness of targeted instructional strategies in enhancing science learning among diverse learners at Iligan City National School of Fisheries, a technical-vocational secondary school. Sixty Grade 9 students with varied linguistic, cultural, and academic backgrounds participated. The study implemented differentiated instruction, active learning, culturally responsive teaching, and technology-enhanced lessons to create an inclusive learning environment. A mixed-methods design was employed, including pre- and post-tests (validated and reliable, Cronbach's $\alpha \geq 0.82$), student surveys ($\alpha \geq 0.85$), classroom observations, and informal interviews. Quantitative data were analyzed for mean improvement and effect sizes, while qualitative data underwent thematic analysis. Results indicated statistically and educationally significant gains, with large effect sizes in scientific knowledge ($d = 1.05$), engagement ($d = 0.85$), and attitudes toward science ($d = 0.80$). Students demonstrated enhanced conceptual understanding, active participation, and more positive attitudes toward science learning. Key barriers included limited English proficiency, cultural-linguistic differences, and resource constraints, which were mitigated through culturally responsive teaching and scaffolded supports. Findings suggest that inclusive, learner-centered strategies can significantly improve science performance, engagement, and equity, offering practical insights for technical-vocational education.

Keywords: science education, diverse learners, differentiated instruction, active learning, culturally responsive teaching, technology-enhanced learning, action research

INTRODUCTION

Science education in the Philippines plays a vital role in preparing students for careers in STEM fields and developing essential competencies for the modern world. However, schools such as Iligan City National School of Fisheries face challenges in addressing the needs of diverse learners—students with varied cultural backgrounds, learning styles, linguistic capacities, and socio-economic conditions.

Traditional teacher-centered instruction often fails to meet these needs, resulting in disengagement and low performance. Literature emphasizes the importance of inclusive and differentiated teaching strategies (Tomlinson, 2014; Gay, 2018), active learning approaches (Bonwell & Eison, 1991; Santos & Magbanua, 2015), and culturally responsive pedagogy to ensure equitable learning.

Recognizing these gaps, this study explores and evaluates instructional innovations that enhance science learning for diverse learners at Iligan City National School of Fisheries. Specifically, it seeks to test the effectiveness of active learning, differentiated instruction, and technology-enhanced activities in improving students' engagement, understanding, and performance.

METHODS

Research Design

This study employed an Action Research design with iterative cycles of planning, intervention, observation, and reflection. Action research was chosen to allow for systematic evaluation and refinement of instructional

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

strategies in response to the needs of diverse learners. This design facilitated real-time adjustments to teaching practices while maintaining a focus on student learning outcomes.

Participants

The study involved 60 Grade 9 learners (SY 2023–2024) at Iligan City National School of Fisheries. Participants represented diverse learning profiles, including variations in linguistic proficiency, cultural background, academic performance, and motivation levels. Inclusion criteria included enrolment in the target science class and consent to participate. Demographic information was collected to contextualize the findings and improve external validity.

Interventions

The study implemented four complementary instructional strategies to enhance science learning:

Differentiated Instruction

1. Flexible grouping based on learning style, ability, and interest.
2. Scaffolded learning supports tailored to individual needs.
3. Varied tasks and assessments to accommodate multiple intelligences.

Active Learning Strategies

1. Hands-on experiments and demonstrations.
2. Problem-solving and inquiry-based tasks.
3. Collaborative group projects to foster peer learning.

Culturally Responsive Teaching

1. Integration of students' cultural and community contexts.
2. Use of locally relevant examples related to fisheries and marine ecosystems.

Technology Integration

1. Interactive simulations and virtual laboratories.
2. Multimedia resources for visual and auditory learners.

Data Collection

1. Pre- and Post-Assessments

- A standardized 30-item science test measured knowledge, comprehension, and application of scientific concepts.
- Test items were validated through expert review and pilot testing with a similar group of students to ensure content validity.
- Reliability was established using Cronbach's alpha ($\alpha = 0.82$), indicating good internal consistency.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

2. Student Surveys

- Likert-scale questionnaires assessed engagement, motivation, and attitudes toward science.
- Survey validity was checked with a panel of three science educators, and reliability was verified with a pilot Cronbach's alpha of $\alpha = 0.85$.

3. Classroom Observations

- Structured observation protocols recorded participation, collaboration, and on-task behavior.
- Inter-rater reliability was established by training two observers, achieving 90% agreement.

4. Interviews / Informal Discussions

- Semi-structured interviews identified learning barriers, student perceptions, and the effectiveness of interventions.
- Notes were triangulated with survey and observation data for credibility.

Data Analysis

Quantitative Data: Mean scores, percentage improvements, and effect sizes (Cohen's d) were calculated to evaluate learning gains:

$$\text{Cohen's d} = \frac{\text{Mean}_{post} - \text{Mean}_{pre}}{\text{pooled SD}}$$

Qualitative Data: Observational notes and interview responses were analyzed using thematic coding to identify recurring challenges, strategies, and student experiences.

Barriers Analysis: Frequencies and percentages quantified common learning obstacles

RESULTS

1. Science Performance Improvement

Category	Pre-test Mean	Post-test Mean	Improvement	Cohen's d
Scientific Knowledge	65	78	13%	1.05
Engagement (Likert 1–5)	3.2	4.1	28%	0.85
Attitude Toward Science (Likert 1–5)	2.8	3.6	29%	0.80

Key Insight: Statistically meaningful improvements were observed in knowledge, engagement, and attitudes. Cohen's d values above 0.8 indicate large effect sizes, supporting the effectiveness of the interventions.

Engagement and Understanding

Category	Pre	Post	Improvement
Engagement	3.2	4.1	28%
Conceptual Understanding	60	72	20%

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

Observation: Hands-on activities and collaborative learning significantly enhanced participation and conceptual grasp, particularly among learners with lower prior achievement.

Barriers Faced by Learners

Barrier	Frequency (%)
Limited English proficiency	35
Cultural/linguistic differences	25
Learning disabilities	20
Low motivation/self-confidence	15
Inadequate instructional resources	10

Interpretation: Language-related barriers were the most prevalent, highlighting the need for linguistically and culturally responsive interventions. Technology-supported scaffolds proved particularly helpful for students facing comprehension challenges.

DISCUSSION

Effectiveness of Instructional Strategies

The findings demonstrate that inclusive, student-centered teaching approaches significantly improve learning outcomes. Differentiated instruction, active learning, and technology integration allowed students to engage with content at appropriate levels, fostering both cognitive and affective gains. The large effect sizes suggest these gains were not only statistically significant but educationally meaningful.

Addressing Learning Barriers

The study confirms that linguistic and cultural challenges are critical obstacles in science education. Incorporating culturally relevant examples and scaffolded supports reduced comprehension gaps. Active learning also helped students with low motivation by making lessons more interactive and personally meaningful. Nevertheless, resource constraints limited the full potential of interventions, indicating a need for school-level investment in technology and materials.

Alignment with Literature

Results align with previous research:

- Tomlinson (2014) emphasizes that differentiated instruction improves achievement for diverse learners.
- Bonwell & Eison (1991) highlight that active learning increases engagement and retention.
- Gay (2018) supports culturally responsive teaching as essential for inclusivity.
- This study extends these findings to a technical-vocational context, particularly in fisheries education.

Implications for Practice

- Schools should adopt a combination of differentiated instruction, active learning, and technology to accommodate diverse learner needs.
- Teacher training programs must emphasize inclusive pedagogy and culturally responsive strategies.
- Addressing resource gaps is crucial for sustainable implementation.
- Future research should expand the study to multiple classes or schools, apply inferential statistics, and track long-term retention and application of scientific knowledge.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

Limitations and Sustainability

While outcomes were promising, this study was limited to a single class and short-term interventions. Sustainability depends on continued teacher support, ongoing professional development, and resource allocation. Reflection cycles allowed immediate adaptation, but long-term impact should be evaluated through follow-up assessments and longitudinal studies.

CONCLUSION

The findings of this action research confirm that the academic performance and engagement of diverse learners in science can be significantly improved through the strategic implementation of inclusive instructional frameworks. By integrating differentiated instruction, active learning, culturally responsive pedagogy, and technology-integrated lessons, this study successfully addressed the varied cognitive and linguistic needs of Grade 9 students. The data revealed that these learner-centered approaches not only bolstered scientific knowledge—increasing mean scores from 65 to 78—but also fostered more positive attitudes toward the subject.

However, the study also highlighted that instructional innovation alone cannot overcome all educational hurdles. The persistence of language barriers and resource limitations underscores the need for a holistic approach to science education that includes institutional support and localized curricula. Ultimately, this research demonstrates that when pedagogical strategies are flexible and culturally grounded, science becomes more accessible, providing a foundation for equitable learning opportunities in technical-vocational secondary schools.

RECOMMENDATIONS

Based on the findings and the identified limitations of this study, the following recommendations are proposed to enhance pedagogical practice and strengthen future research in inclusive science education:

For Educational Practice

Institutionalize Learner-Centered Frameworks: Schools should transition from traditional, lecture-heavy models toward a hybrid of active learning and differentiated instruction.

Adopt Scaffolded Lesson Planning: Educators should implement lesson plans that offer various entry points, accommodating students' prior knowledge and specific cognitive needs.

Prioritize Culturally Responsive Pedagogy: Science curricula should be localized by integrating indigenous knowledge, local environmental contexts (such as the fisheries industry), and multilingual glossaries to bridge cultural and linguistic gaps.

Strategic Technology Integration: Rather than using technology as a supplementary tool, institutions should utilize assistive digital resources, such as interactive simulations, to support students with limited language proficiency or learning disabilities.

Sustained Professional Development: Districts should move beyond one-off workshops and implement continuous, mentor-based training programs focused on inclusive science strategies.

For Future Research

Expansion of Study Scale and Diversity: Future investigations should employ longitudinal designs involving larger, multi-site samples across urban, rural, and international settings to improve the generalizability of the findings.

Methodological Rigor and Inferential Analysis: Researchers should move beyond descriptive statistics to include control groups and inferential statistical tests—such as t-tests, ANOVA, or Cohen’s d effect size calculations—to quantify the significance of instructional impact.

Instrument Validation: To enhance credibility in the international academic community, future studies must provide explicit data on the validity and reliability of assessment tools, including Cronbach's alpha scores and factor analyses.

Sustainability and Policy Analysis: Further research is needed to investigate the long-term retention of scientific concepts and the institutional bottlenecks, such as resource scarcity, that may hinder the permanent adoption of inclusive practices

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