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Inquiry-Based Science Pedagogy and Learners' Academic Engagement at Andabuen National High School

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Abstract

Inquiry-based pedagogy has been widely advocated as an effective instructional approach for promoting active learning and academic engagement in science education. However, empirical evidence using quasi-experimental designs in public secondary schools remains limited, particularly in rural Philippine contexts. This study employed a quasi-experimental research design to examine the effects of inquiry-based science pedagogy on learners' academic engagement at Andabuen National High School. Two intact Grade 9 classes were assigned as the experimental group (inquiry-based instruction) and the control group (traditional lecture-based instruction). Academic engagement was measured across behavioral, emotional, and cognitive dimensions using a validated engagement questionnaire. Data were analyzed using descriptive statistics, paired samples *t*-tests, and independent samples *t*-tests. Results indicated that learners exposed to inquiry-based instruction demonstrated significantly higher post-test engagement across all dimensions compared to those in the control group. The findings provide empirical support for inquiry-based pedagogy as an effective approach for enhancing academic engagement in secondary science classrooms.

Keywords: inquiry-based learning, science pedagogy, academic engagement, quasi-experimental study, secondary education

1. Introduction

Academic engagement is a critical determinant of meaningful learning and academic success in science education. Learners who are behaviorally involved, emotionally invested, and cognitively engaged are more likely to develop scientific understanding, critical thinking skills, and sustained interest in science learning. However, science instruction in many secondary classrooms continues to rely heavily on teacher-centered, lecture-based approaches that emphasize content coverage over inquiry and active participation.

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In response to these challenges, inquiry-based science pedagogy has been promoted as a learner-centered approach that mirrors the practices of scientists by encouraging questioning, investigation, evidence-based reasoning, and reflection. Inquiry-based instruction positions learners as active constructors of knowledge, enabling them to engage deeply with scientific concepts through hands-on and minds-on learning experiences.

Although international research supports the effectiveness of inquiry-based pedagogy, there is a need for context-specific empirical studies that examine its impact on learners' academic engagement, particularly in Philippine public secondary schools. Andabuen National High School provides a relevant context for examining the effects of inquiry-based science instruction, as it serves learners in a resource-constrained environment where traditional teaching approaches remain prevalent. This study sought to examine whether inquiry-based science pedagogy significantly enhances learners' academic engagement compared to traditional instruction.

2. Review of Related Literature

2.1 Inquiry-Based Science Pedagogy

Inquiry-based science pedagogy is grounded in constructivist learning theory, which views learning as an active process of knowledge construction through exploration, questioning, and reflection. Inquiry-based instruction involves learners in posing questions, conducting investigations, analyzing data, and constructing explanations. Studies have shown that inquiry-based learning enhances conceptual understanding, motivation, and engagement in science classrooms (Minner et al., 2010; Lazonder & Harmsen, 2016).

2.2 Academic Engagement in Science Learning

Academic engagement is a multidimensional construct encompassing behavioral engagement (participation and effort), emotional engagement (interest and enjoyment), and cognitive engagement (investment in understanding and problem-solving). Research suggests that inquiry-based environments promote all three dimensions by providing meaningful tasks, autonomy, and opportunities for collaboration (Fredricks et al., 2004).

2.3 Empirical Evidence from Quasi-Experimental Studies

Quasi-experimental studies have demonstrated that inquiry-based instruction leads to higher levels of student engagement and achievement compared to traditional approaches (Furtak et al., 2012). However, findings also indicate that the effectiveness of inquiry-based pedagogy depends on instructional scaffolding and contextual factors, highlighting the need for localized empirical investigations.

3. Methodology

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This study employed a quasi-experimental pretest–posttest non-equivalent groups research design to examine the effects of inquiry-based science pedagogy on learners’ academic engagement. Two intact Grade 9 classes at Andabuen National High School were designated as the experimental and control groups. The experimental group was exposed to inquiry-based science instruction, while the control group received traditional lecture-based teaching. The research was conducted at Andabuen National High School, with a total of 72 Grade 9 students participating in the study 36 learners in each group. The two groups were comparable in terms of age, academic background, and prior exposure to science content, ensuring that observed differences in outcomes could be attributed primarily to the instructional intervention rather than pre-existing characteristics.

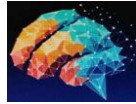
The instructional intervention was implemented over an eight-week period. Learners in the experimental group engaged in inquiry-based science pedagogy that emphasized guided inquiry activities, group investigations, hypothesis formulation, evidence-based reasoning, and reflective classroom discussions. These activities were designed to promote active participation, critical thinking, and collaborative learning. In contrast, the control group received conventional science instruction that focused on teacher-led lectures, textbook-based explanations, and individual seatwork, reflecting commonly used traditional teaching practices.

Learners’ academic engagement was measured using a validated Academic Engagement Questionnaire that assessed three dimensions of engagement: behavioral, emotional, and cognitive. The instrument demonstrated acceptable levels of internal consistency, with Cronbach’s alpha coefficients ranging from .84 to .89, indicating good reliability. Data analysis involved the use of descriptive statistics to determine levels of engagement before and after the intervention. Paired samples *t*-tests were conducted to examine within-group differences between pretest and posttest scores, while independent samples *t*-tests were used to compare posttest engagement levels between the experimental and control groups. All statistical tests were conducted at a .05 level of significance.

4. Results and Findings

Table 1. Pretest and Posttest Academic Engagement of the Experimental Group (Inquiry-Based Instruction)

Engagement Dimension	Test	Mean (\bar{x})	SD	<i>t</i>	<i>p</i>
Behavioral	Pretest	3.42	0.48	6.12	< .001
	Posttest	4.21	0.44		
Emotional	Pretest	3.38	0.52	5.87	< .001
	Posttest	4.18	0.46		
Cognitive	Pretest	3.31	0.50	4.94	< .001
	Posttest	4.02	0.49		



Significant improvements were observed across all dimensions of academic engagement behavioral, emotional, and cognitive following the implementation of inquiry-based instruction, indicating that the pedagogical intervention was effective in enhancing learners' overall engagement in science learning. In terms of behavioral engagement, learners demonstrated increased participation in classroom activities, greater attentiveness during lessons, and more consistent involvement in group investigations and discussions. These changes suggest that inquiry-based instruction successfully shifted learners from passive listening to active participation, as they were regularly required to ask questions, test ideas, and collaborate with peers.

Improvements in emotional engagement were likewise evident after the intervention. Learners reported higher levels of interest, enjoyment, and positive feelings toward science lessons, reflecting a more motivating and supportive learning environment. The opportunity to explore scientific concepts through hands-on inquiry and guided discovery appeared to foster curiosity and reduce anxiety associated with learning complex topics. Such emotional gains are important, as positive affect toward learning has been linked to sustained motivation and persistence in academic tasks.

With regard to cognitive engagement, learners showed greater effort in understanding scientific concepts, increased persistence when faced with challenging problems, and a stronger tendency to reflect on their learning processes. Although cognitive engagement often develops more gradually than behavioral and emotional engagement, the observed gains indicate that inquiry-based instruction encouraged learners to think more deeply, analyze evidence, and construct their own explanations. Collectively, these improvements across all engagement dimensions demonstrate that inquiry-based pedagogy is an effective instructional approach for promoting meaningful and sustained academic engagement in secondary science classrooms.

Table 2. Comparison of Posttest Academic Engagement Between Experimental and Control Groups

Dimension	Group	Mean (\bar{X})	SD	t	p	Interpretation
Behavioral	Inquiry-based	4.21	0.44	4.83	< .001	Significant
	Traditional	3.74	0.51			
Emotional	Inquiry-based	4.18	0.46	4.29	< .001	Significant
	Traditional	3.69	0.54			
Cognitive	Inquiry-based	4.02	0.49	3.17	.002	Significant
	Traditional	3.68	0.56			

Learners in the inquiry-based group demonstrated significantly higher posttest academic engagement than those in the control group across all measured dimensions behavioral, emotional, and cognitive. Specifically, learners exposed to inquiry-based science pedagogy showed greater behavioral engagement, as evidenced by more active participation in classroom discussions, sustained



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involvement in investigative tasks, and increased willingness to collaborate with peers during learning activities. This heightened level of participation suggests that inquiry-based instruction effectively encourages learners to take an active role in the learning process rather than remaining passive recipients of information.

In terms of emotional engagement, learners in the inquiry-based group reported higher levels of interest, enjoyment, and positive attitudes toward science learning compared to their counterparts in traditional classrooms. The opportunity to ask questions, explore scientific phenomena, and make sense of concepts through hands-on investigation appeared to foster a more motivating and supportive learning environment. These findings indicate that inquiry-based pedagogy enhances learners' emotional connection to learning by making science lessons more meaningful and relevant to their experiences.

With respect to cognitive engagement, learners who participated in inquiry-based instruction demonstrated greater investment in understanding scientific concepts, persistence in solving challenging problems, and use of higher-order thinking strategies. Although the magnitude of difference in cognitive engagement was more moderate compared to behavioral and emotional dimensions, the results nonetheless suggest that inquiry-based pedagogy promotes deeper intellectual engagement by requiring learners to analyze data, construct explanations, and reflect on their learning processes. Overall, these findings provide strong empirical evidence that inquiry-based science pedagogy is more effective than traditional instruction in fostering holistic academic engagement among secondary school learners.

5. Discussion

The findings of this study provide strong empirical evidence that inquiry-based science pedagogy significantly enhances learners' academic engagement across behavioral, emotional, and cognitive dimensions. The substantial gains in behavioral engagement observed among learners in the inquiry-based group reinforce prior research emphasizing that inquiry-oriented activities promote active participation, sustained effort, and on-task behavior in science classrooms (Fredricks et al., 2004). Through structured opportunities to ask questions, conduct investigations, and collaborate with peers, learners moved beyond passive listening and became active contributors to classroom learning. Such participation reflects a shift toward learner agency, where students assume greater responsibility for their learning processes.

The significantly higher levels of emotional engagement among learners exposed to inquiry-based instruction further suggest that inquiry-oriented classrooms foster positive affective experiences, including interest, enjoyment, and a sense of relevance in science learning. When learners are encouraged to explore phenomena, test ideas, and draw conclusions based on evidence, science lessons become more meaningful and motivating. This finding is consistent with self-determination theory, which posits that learning environments supporting autonomy, competence, and relatedness enhance learners' intrinsic motivation and emotional engagement (Reeve, 2012). Inquiry-based pedagogy, by

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providing choice, meaningful tasks, and collaborative interaction, appears to satisfy these psychological needs, thereby strengthening learners' emotional connection to learning.

Moreover, the observed improvement in cognitive engagement indicates that inquiry-based science pedagogy supports deeper learning and higher-order thinking. Learners demonstrated greater persistence in addressing challenging tasks, increased effort in understanding scientific concepts, and more frequent use of reasoning and reflection during learning activities. These outcomes align with the findings of Furtak et al. (2012), who reported that inquiry-based instruction particularly when supported by appropriate scaffolding enhances learners' cognitive involvement and conceptual understanding. Although cognitive engagement often requires sustained exposure and intentional instructional design, the results of this study suggest that inquiry-based pedagogy creates conditions conducive to meaningful intellectual engagement by engaging learners in evidence-based reasoning and problem-solving.

Taken together, these findings underscore the effectiveness of inquiry-based science pedagogy in fostering holistic academic engagement. By simultaneously enhancing behavioral participation, emotional investment, and cognitive effort, inquiry-based instruction supports not only active learning but also the development of enduring interest and deeper understanding in science education.

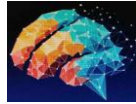
6. Conclusions and Implications

This quasi-experimental study concludes that inquiry-based science pedagogy is significantly more effective than traditional lecture-based instruction in enhancing learners' academic engagement at Andabuen National High School. Learners who were exposed to inquiry-oriented teaching demonstrated higher levels of behavioral participation, as reflected in active involvement in discussions, investigations, and collaborative tasks. They also exhibited stronger emotional investment, characterized by increased interest, enjoyment, and positive attitudes toward science learning. Moreover, inquiry-based instruction supported greater cognitive effort, encouraging learners to persist in challenging tasks, analyze evidence, and construct explanations based on scientific reasoning. Collectively, these outcomes indicate that inquiry-based pedagogy creates learning environments that are more engaging, meaningful, and supportive of deep learning in science education.

Implications for Practice. The findings suggest that science teachers should intentionally integrate inquiry-based strategies into their classroom practice, including opportunities for learners to pose questions, design and conduct investigations, analyze data, and reflect on their learning processes. Providing structured guidance and scaffolding within inquiry activities can help ensure that learners remain cognitively engaged while developing scientific thinking skills. By shifting the instructional focus from content transmission to exploration and sense-making, teachers can foster sustained academic engagement among learners.

Implications for School Leadership. School leaders play a critical role in sustaining inquiry-based pedagogy by creating institutional conditions that support its implementation. This includes providing ongoing professional development focused on inquiry-oriented teaching strategies, facilitating

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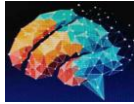
collaborative planning among science teachers, and ensuring access to instructional resources that enable hands-on and minds-on learning experiences. Leadership support is essential for aligning curriculum, assessment, and instructional practices with inquiry-based approaches.

Directions for Future Research. Future studies may extend the present findings by examining the long-term effects of inquiry-based science instruction on learners' academic achievement, scientific literacy, and attitudes toward science. Longitudinal or mixed-methods research designs could provide deeper insights into how sustained exposure to inquiry-based pedagogy influences learners' engagement trajectories over time. Additionally, research conducted across multiple schools and diverse contexts would enhance the generalizability of findings and inform broader implementation of inquiry-based science education.

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