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

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ABSTRACT

Inquiry-based teaching has been widely promoted as an effective pedagogical approach for improving student engagement and learning in science education. However, empirical evidence grounded in school-based classroom practice remains limited, particularly in secondary school contexts. This study examined how inquiry-based science teaching influenced learners' academic engagement at Andabuen National High School. Using a qualitative case study design, data were collected through classroom observations, semi-structured interviews with science teachers, and focus group discussions with learners. Thematic analysis revealed that inquiry-based instruction enhanced behavioral, emotional, and cognitive engagement when teachers structured lessons around questioning, investigation, collaborative sense-making, and reflective dialogue. Learners demonstrated increased participation, sustained interest, and deeper cognitive involvement when inquiry tasks were supported by scaffolding, feedback, and a supportive classroom climate. The findings underscore the importance of intentional instructional design and instructional leadership support in sustaining inquiry-based practices. Implications for science teaching and future research directions are discussed.

Keywords: *inquiry-based learning, science education, academic engagement, secondary education, learner-centered pedagogy*

I. INTRODUCTION

Academic engagement is widely recognized as a critical determinant of learning quality and academic success, particularly in science education where conceptual understanding and problem-solving are essential. Engagement is commonly understood as a multidimensional construct encompassing learners' behavioral participation, emotional involvement, and cognitive investment in learning activities. Research consistently shows that engaged learners demonstrate greater persistence, deeper understanding, and stronger academic outcomes than their disengaged peers (Appleton, Christenson, & Furlong, 2008; Sinatra, Heddy, & Lombardi, 2015).

In science classrooms, however, engagement remains a persistent challenge. Traditional instructional practices that emphasize lecture-based delivery, rote memorization, and algorithmic problem-solving often limit opportunities for learners to ask questions, explore phenomena, and construct scientific understanding actively. Such approaches may result in surface-level participation without genuine cognitive engagement or sustained interest (National Research Council, 2000). In response, inquiry-based teaching has gained prominence as a learner-centered approach that aligns with the nature of scientific inquiry and promotes meaningful engagement.

Inquiry-based science teaching positions learners as active investigators who generate questions, collect and analyze data, construct explanations, and communicate findings. Teachers serve as facilitators who guide inquiry processes through questioning, scaffolding, and feedback rather than direct transmission of information. Studies suggest that inquiry-based approaches foster curiosity, motivation, and deeper conceptual understanding by engaging learners in authentic scientific practices (Hmelo-Silver, Duncan, & Chinn, 2007; Minner, Levy, & Century, 2010).

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Despite its theoretical and empirical support, the implementation of inquiry-based teaching in secondary schools varies considerably. Many teachers face constraints related to time, curriculum demands, assessment pressures, and limited professional support, resulting in partial or superficial enactment of inquiry practices. Consequently, there is a need for context-specific research that examines how inquiry-based teaching operates in actual classroom settings and how it influences learners' engagement.

This study addresses this gap by examining inquiry-based science teaching and its impact on learners' academic engagement at Andabuen National High School. Rather than treating inquiry-based teaching as a broad instructional orientation, the study focuses on concrete classroom practices and learners' engagement responses during science lessons.

II. REVIEW OF RELATED LITERATURE

2.1 Academic Engagement in Science Learning

Academic engagement has been conceptualized as comprising behavioral, emotional, and cognitive dimensions. Behavioral engagement includes observable actions such as participation in activities, effort, and persistence; emotional engagement involves learners' interest, enjoyment, and sense of belonging; and cognitive engagement refers to learners' strategic thinking, self-regulation, and willingness to exert effort to understand complex ideas (Fredricks, Blumenfeld, & Paris, 2004). In science education, engagement is particularly important because meaningful learning requires learners to actively reason, hypothesize, and connect evidence to explanations.

Research emphasizes that engagement is context-dependent and highly responsive to instructional practices. Science classrooms that encourage inquiry, discussion, and experimentation tend to foster higher levels of engagement than those dominated by passive listening and note-taking (Osborne, Simon, & Collins, 2003).

2.2 Inquiry-Based Science Teaching

Inquiry-based teaching is grounded in constructivist and sociocultural theories of learning, which view knowledge as actively constructed through interaction with the environment and others. Inquiry-based instruction engages learners in processes similar to those used by scientists, including asking questions, designing investigations, interpreting data, and communicating explanations (National Research Council, 2000).

Empirical studies have shown that inquiry-based science teaching is positively associated with improved engagement and learning outcomes, particularly when inquiry tasks are structured and supported. Minner et al. (2010) found that inquiry-oriented instruction had a positive impact on students' conceptual understanding and engagement when learners were actively involved in data analysis and explanation building. However, unguided inquiry may overwhelm learners, underscoring the importance of teacher scaffolding (Kirschner, Sweller, & Clark, 2006).

2.3 Teacher Support and Engagement in Inquiry Contexts

Effective inquiry-based teaching requires teachers to balance learner autonomy with instructional structure. Teachers' questioning strategies, feedback, and facilitation skills play a critical role in sustaining learners' engagement and guiding productive inquiry (Lazonder & Harmsen, 2016). Supportive classroom environments that encourage exploration, accept errors as part of learning, and promote collaboration further enhance learners' emotional and cognitive engagement.

III. METHODOLOGY

This study employed a qualitative case study research design to examine inquiry-based science teaching and learners' academic engagement at Andabuen National High School. The case study approach was appropriate for exploring instructional practices and learner experiences within a natural classroom context. The research site was purposively selected due to its implementation of inquiry-based strategies in science instruction.

Participants included science teachers and secondary school learners who were directly involved in inquiry-based science lessons. Data were collected through classroom observations, semi-structured interviews with science teachers, and focus group discussions with learners. Classroom observations focused on instructional strategies, inquiry tasks, teacher–learner interactions, and learner participation patterns. Teacher interviews explored pedagogical intentions, challenges, and perceptions of learner engagement, while learner focus group discussions elicited experiences, interests, and perceived learning during inquiry-based lessons.

Data analysis followed a thematic analysis approach. Observation notes and interview transcripts were coded inductively, and recurring patterns were organized into themes related to inquiry-based teaching practices and engagement outcomes. Trustworthiness was ensured through triangulation of data sources, member checking, and peer debriefing. Ethical considerations included informed consent, confidentiality, and the use of pseudonyms.

IV. FINDINGS AND RESULTS

Analysis of classroom observations, teacher interviews, and learner focus group discussions revealed four major themes that explain how inquiry-based science teaching influenced learners' academic engagement at Andabuen National High School. These themes capture the interaction between instructional practices and learners' behavioral, emotional, and cognitive engagement.

Theme 1: Strengthened Behavioral Engagement through Active Participation in Scientific Inquiry

Inquiry-based science lessons consistently required learners to engage actively in hands-on investigations, group experiments, and problem-solving tasks. Teachers organized lessons around observable phenomena, guiding learners to design simple procedures, manipulate materials, record data, and share observations. These inquiry tasks replaced prolonged teacher talk with sustained learner activity, ensuring that most learners were physically and cognitively involved throughout the lesson.

Teachers observed noticeable changes in learner participation during inquiry-based lessons. One teacher explained, *"Kapag inquiry ang lesson, bihira ang walang ginagawa. Kahit ang tahimik na estudyante ay may bahagi sa gawain."* Learners similarly reported increased involvement, with one stating, *"Hindi kami bored kasi may ginagawa kami at hindi lang nakikinig."*

These accounts indicate that inquiry-based instruction enhanced behavioral engagement by providing clear roles, shared responsibility, and continuous tasks that demanded learner action. Active participation reduced off-task behavior and increased time-on-task, supporting the view that engagement is strengthened when learners are positioned as active contributors rather than passive recipients of information.

Theme 2: Heightened Emotional Engagement through Curiosity, Interest, and Relevance

Inquiry-based teaching fostered emotional engagement by stimulating learners' curiosity and interest in scientific phenomena. Lessons often began with puzzling questions or demonstrations that encouraged learners to wonder, predict, and explore. Teachers intentionally delayed direct explanations, allowing learners to experience uncertainty and curiosity as part of the learning process.

Learners expressed excitement and enjoyment during inquiry lessons. One learner shared, *"Masaya ang science kapag kami ang naghahanap ng sagot. Nakaka-curious kung tama ang sagot namin."* Teachers also noted increased enthusiasm, stating that learners were more eager to ask questions and share ideas when lessons involved inquiry activities rather than lectures.

These findings suggest that inquiry-based teaching enhanced emotional engagement by making learning experiences meaningful and intellectually stimulating. By allowing learners to explore questions and discover patterns, inquiry-based instruction promoted positive emotions toward learning, which are critical for sustained engagement and motivation in science education.

Theme 3: Deepened Cognitive Engagement through Guided Investigation and Sense-Making

Cognitive engagement was most evident when inquiry activities were supported by teacher scaffolding, guiding questions, and reflective discussion. Teachers facilitated learners' thinking by prompting them to explain observations, justify conclusions, and connect findings to scientific concepts. Rather than providing answers immediately, teachers encouraged learners to analyze results and articulate reasoning.

Teachers emphasized the importance of guidance in inquiry. One teacher noted, *"Hindi puwedeng pabayaan lang. Kailangan ng tanong na gagabay para mag-isip ang mga bata."* Learners echoed this perspective, explaining that discussing results helped them understand lessons better: *"Mas naiintindihan ko kapag ipinapaliwanag namin kung bakit ganoon ang nangyari."*

These responses indicate that inquiry-based teaching promoted deeper cognitive engagement when learners were guided to reflect on evidence and construct explanations. Instructional scaffolding enabled learners to engage in higher-order thinking, supporting conceptual understanding rather than surface-level task completion.

Theme 4: Sustained Engagement through Collaborative Inquiry and Supportive Classroom Climate

Inquiry-based science instruction frequently involved collaborative learning, with learners working in small groups to conduct investigations and interpret results. Teachers fostered a supportive classroom climate by encouraging cooperation, valuing multiple ideas, and treating errors as opportunities for learning.

Learners reported feeling more confident participating in group inquiry tasks. One learner shared, *"Hindi ako natatakot magkamali kasi nagtutulungan kami."* Teachers observed that collaboration increased learners' willingness to participate and persist in challenging tasks.

These findings suggest that collaborative inquiry and a supportive classroom environment sustained engagement by reducing fear of failure and promoting shared learning responsibility. The social dimension of inquiry allowed learners to learn from peers while maintaining motivation and focus.

V. DISCUSSION

The findings of this study demonstrate that inquiry-based science teaching at Andabuen National High School enhanced learners' academic engagement across behavioral, emotional, and cognitive dimensions. Consistent with multidimensional engagement theory, learners were most engaged when instruction combined active participation, emotional relevance, and cognitive challenge. Inquiry tasks served as participation structures that required learners' sustained involvement, addressing behavioral engagement by increasing time-on-task and reducing passivity.

Emotional engagement was strengthened through curiosity-driven learning experiences that positioned learners as investigators rather than passive listeners. Allowing learners to explore questions and generate explanations fostered interest, enjoyment, and a sense of ownership over learning. These findings align with research emphasizing the motivational value of inquiry-based instruction in science education, particularly when learners perceive learning as meaningful and exploratory rather than prescriptive.

Cognitive engagement was most evident when inquiry was guided rather than unguided. Teachers' use of scaffolding, questioning, and reflection enabled learners to engage in sense-making and higher-order thinking. This supports prior research arguing that inquiry-based learning is most effective when autonomy is balanced with instructional structure, ensuring that learners are challenged without being overwhelmed.

The role of collaboration and classroom climate further highlights the social nature of engagement in inquiry contexts. Collaborative inquiry reduced anxiety and encouraged learners to persist through difficulties, reinforcing the idea that engagement is co-constructed through social interaction and supportive teacher–learner relationships. Together, these findings suggest that inquiry-based teaching enhances engagement not simply by increasing activity, but by creating instructional conditions that support participation, curiosity, and deep thinking.

VI. IMPLICATIONS OF THE STUDY

The findings of this study offer important implications for science teaching practice. Science teachers are encouraged to design inquiry-based lessons that actively involve learners in questioning, investigating, and explaining scientific phenomena. Inquiry tasks should be intentionally structured to ensure active participation and supported through guiding questions, scaffolding, and formative feedback. Emphasizing reflection and explanation can further strengthen learners' cognitive engagement and conceptual understanding.

The study also highlights the importance of fostering a supportive and collaborative classroom climate. Teachers are encouraged to promote group inquiry, normalize errors as part of the learning process, and create an environment where learners feel safe to share ideas and ask questions. Such practices can enhance learners' emotional engagement and willingness to persist in challenging tasks.

At the level of instructional leadership, school administrators play a crucial role in sustaining inquiry-based science teaching. Professional development programs should focus on strengthening teachers' inquiry facilitation skills, including question design, scaffolding strategies, and assessment of inquiry processes. Providing adequate resources, laboratory materials, and time for collaborative planning can further support the effective implementation of inquiry-based instruction.

Finally, the study suggests directions for future research. Subsequent studies may employ mixed-methods designs to examine the relationship between inquiry-based teaching, engagement, and achievement outcomes across multiple schools. Longitudinal research may also explore how sustained exposure to inquiry-based science instruction influences learners' motivation, scientific thinking, and long-term academic engagement.

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