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# Investigating The Effectiveness Of Inquiry-Based Learning Approaches In Promoting Students Engagement, Critical Thinking, And Conceptual Understanding In Science Classrooms Among Secondary School Students In Jega Local Government

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## ABSTRACT

The research is to investigate the investigating the effectiveness of inquiry-based learning approaches in promoting students engagement, critical thinking, and conceptual understanding in science classrooms among secondary school students in jega local government. The following objectives was used by the research evaluate the impact of inquiry-based learning methods on students' engagement levels in science classrooms, assess how inquiry-based learning approaches contribute to the development of critical thinking skills among secondary school students, investigate the effectiveness of inquiry-based learning in enhancing students' conceptual understanding of scientific concepts and analyze the relationship between inquiry-based learning methods and students' performance in science education in secondary schools. The study will employ a mixed-methods research design, integrating quantitative surveys, the population for this research consists of 117 senior secondary school teachers and 270 students in Jega local government area, Kebbi State, Nigeria the sample of the study is Twenty (25) teachers (15 males and 10 females) would be selected from the chosen schools for interview. Similarly, fifty (160) students would randomly be selected. The findings of this study highlight the challenges and limited impact of inquiry-based learning (IBL) methods on student engagement, critical thinking, conceptual understanding, and academic performance in secondary school science education. The data collected from the respondents indicate that students do not perceive IBL as significantly enhancing their learning experiences. The researchers come with the following recommendations: Schools and educational authorities should organize regular workshops and training sessions to equip teachers with the necessary skills and knowledge to implement IBL effectively, governments and school administrations should provide adequate resources, including laboratory equipment, instructional materials, and digital tools, to support inquiry-based learning, Teachers should adopt strategies to actively involve students in IBL processes, such as collaborative learning, real-world problem-solving, and project-based assessments, Schools should leverage digital tools, online simulations, and virtual laboratories to enhance the inquiry-based learning experience and continuous assessment mechanism should be established to monitor the effectiveness of IBL and make necessary adjustments based on student performance and feedback.

Keywords: Inquiry based learning, engagement, critical thinking

## INTRODUCTION

In recent years, there has been a growing interest in exploring innovative teaching methodologies to enhance student engagement, critical thinking, and conceptual understanding in science classrooms, particularly among secondary school students. One such approach that has gained attention is the use of inquiry-based learning. Inquiry-based learning emphasizes active student participation, problem-solving, and exploration, aiming to foster a deeper understanding of scientific concepts (Abd-El-Khalick et al., 1998).

Research has shown that creating equitable classroom cultures that support collaborative sense making and foster a sense of belonging can significantly impact students' interest in science, especially those from historically marginalized populations (Singleton, 2024). Additionally, studies have highlighted the importance of critical thinking skills in academic achievement, emphasizing the relationship between critical thinking instructional practices, skills, dispositions, and student performance in science subjects (Ali & Awan, 2021).

Moreover, investigations into instructional effectiveness and classroom dynamics have been recommended to design more effective educational environments and measure students' critical thinking skills using a combination of qualitative and quantitative research techniques (Gencer & Doğan, 2020). Studies have also indicated that teachers' self-efficacy in implementing inquiry-based instruction is influenced by their teaching experience, underscoring the significance of continuous professional development in this area (Seneviratne et al., 2020).

Furthermore, the impact of eliciting and being responsive to students' initial ideas on disciplinary engagement has been explored, revealing a connection between teacher responsiveness, student engagement, and the continued use of ideas across instructional units (Gray et al., 2022). The flipped classroom approach has been identified as a strategy that can increase student engagement, encourage critical thinking, and improve attitudes towards learning (Tanner & Scott, 2015).

Lastly, this research aims to investigate the effectiveness of inquiry-based learning approaches in promoting student engagement, critical thinking, and conceptual understanding in science classrooms among secondary school students in Jega Local Government. By synthesizing findings from various studies on instructional practices, critical thinking skills, student engagement, and teaching strategies, this study seeks to contribute to the ongoing discourse on enhancing science education for secondary school students.

### Statement of the Problem

The research problem under investigation focuses on examining the effectiveness of inquiry-based learning approaches in enhancing student engagement, critical thinking, and conceptual understanding in science classrooms among secondary school students in Jega Local Government. This study aims to explore the impact of implementing various inquiry-based learning models on students' critical thinking skills within the context of science education.

Inquiry-based learning has been acknowledged as a pedagogical approach that can significantly influence students' critical thinking abilities (Liang et al., 2021). By involving students in inquiry processes, they are encouraged to think critically, solve problems creatively, and develop a deeper conceptual understanding of scientific concepts (Liang et al., 2021). Previous studies have demonstrated that inquiry-based learning can promote high-order cognitive skills, such as critical thinking and creative problem-solving abilities, which are crucial in science education (Liang et al., 2021).

Additionally, research has shown that the effectiveness of inquiry learning models in enhancing critical thinking skills has been evidenced across various subjects, including mathematics and science (Samadun et al., 2023). These studies have underscored the positive impact of inquiry-based approaches on students' critical thinking abilities, underscoring the significance of such pedagogical strategies in fostering cognitive development (Samadun et al., 2023).

**Research Objectives**

This study aims to Investigate the Effectiveness of Inquiry-Based Learning Approaches in Promoting Students Engagement, Critical Thinking, and Conceptual Understanding in Science Classrooms among Secondary School Students in Jega Local Government.

The specific objectives are:

1. Evaluate the impact of inquiry-based learning methods on students' engagement levels in science classrooms.
2. Assess how inquiry-based learning approaches contribute to the development of critical thinking skills among secondary school students.
3. Investigate the effectiveness of inquiry-based learning in enhancing students' conceptual understanding of scientific concepts.
4. Analyze the relationship between inquiry-based learning methods and students' performance in science education in secondary schools.

**Research Questions**

1. How does the implementation of inquiry-based learning methods affect students' engagement levels in science classrooms?
2. What is the contribution of inquiry-based learning approaches to the development of critical thinking skills among secondary school students
3. In what ways does inquiry-based learning enhance students' conceptual understanding of scientific concepts
4. What is the relationship between the utilization of inquiry-based learning methods and students' performance in science education in secondary schools.

**Review Of Related Literature**

Inquiry-Based Learning is rooted in constructivist theories of learning, particularly those of Piaget and Vygotsky, which emphasize knowledge construction through active exploration. A study by Pedaste et al. (2015) observed different phases of Inquiry-Based Learning, which are including orientation, conceptualization, investigation, conclusion, and discussion, forming a cyclic model for effective science teaching and learning.

Student engagement is a very important and essential determinant of academic achievement and success. Research by Siantuba, Nkhata, and de Jong (2023) suggests that online Inquiry-Based Learning environments help address misconceptions and improve student academic performance. Additionally, a meta-analysis by Lazonder and Harmsen (2016) discovered that Inquiry-Based Learning is more effective than traditional instructional methods (approaches), provided students receive adequate guidance.

Critical thinking skill in science education is fundamental, and inquiry base learning gives chances and opportunities for students to develop higher order cognitive abilities. A study by Xu, Wang and Wang (2023) investigated the usefulness of collaborative problem solving in promoting critical thinking and also observed that structured inquiry activities significantly increase students' analytical skills. Moreover, research by Guo and Lee (2023) shows how AI driven inquiry based interventions can increase deeper questioning and analysis skills among students.

Inquiry base learning assists in the development of understanding of concept by giving students opportunities and chances to scrutinize scientific principles through solving problem skill and experimentation. According to Wen et al. (2023), while integrating augmented reality into inquiry based learning increases students' ability to grasp scientific phenomena that are complex. Similarly, Resenberg et al. (2022) investigated that using real world data sources in inquiry base learning classrooms reinforces and increases students conceptual understanding.

With all these benefits, Inquiry-Based Learning faces many implementation challenges. Limitation of teacher training and lack of adequate resources can hinder the successful adoption of Inquiry-Based Learning strategies. Research by Pun, Fu, and Cheung (2023) underscores language barriers in English-medium instruction science classrooms, which can affect students' ability to engage with inquiry-based

tasks. Additionally, An and Macaro (2022) highlight the challenges of monolingual instruction in Inquiry-Based Learning settings, emphasizing the need for scaffolding to support diverse learners.

Base on the literature reviewed, it confirms that Inquiry-Based Learning significantly enhances student engagement, fosters critical thinking, and promotes conceptual understanding in secondary science education. However, effective implementation requires well-structured guidance, technological integration, and professional development for educators.

Inquiry-based learning approaches have gained significant attention in science education due to their potential to enhance student engagement, critical thinking, and conceptual understanding. Studies such as those by Ruiz-Martín & Bybee (2022) have shown that inquiry-based approaches, like the 5E Model of Instruction, lead to improved conceptual understanding, decreased prevalence of alternative conceptions, enhanced achievement in science, increased interest in scientific careers, and positive attitudes towards science. Similarly, research by Yilmaz & Kaya (2016) and Santyasa et al. (2018) have demonstrated the positive impact of inquiry-based learning on academic achievement and conceptual understanding in science subjects among students.

Moreover, the effectiveness of inquiry-based activities on academic achievement and problem-solving skills has been highlighted in studies like that of Güven and Nas (GÜVEN & NAS, 2022). These studies emphasize the importance of authentic learning approaches and inquiry-based activities in promoting students' academic success and problem-solving abilities.

Furthermore, the conceptual change model has been identified as a valuable tool in addressing misconceptions and improving conceptual understanding in science education (Addido et al., 2022). This model has been found to be effective in enhancing students' learning experiences and fostering a deeper understanding of scientific concepts.

The effectiveness of inquiry-based learning in science classrooms has been linked to improved student achievement (Montebon, 2016). Furthermore, integrating inquiry-based teaching methods into classrooms has been found to positively impact learning outcomes and shape teachers' attitudes towards this approach (Kreifels et al., 2021).

Studies have highlighted the importance of teacher preparedness and practices in implementing inquiry-based instruction. Research has shown that science teachers' perspectives and practices play a crucial role in the successful implementation of inquiry-based science instruction (Paudel, 2020). Additionally, the self-efficacy of science teachers in utilizing instructional strategies, managing classrooms, and engaging students in scientific inquiry has been identified as a key factor influencing the effectiveness of inquiry-based learning (Seneviratne et al., 2020).

Professional development plays a vital role in supporting teachers in facilitating inquiry-based instruction. It has been suggested that inquiry professional development should not only focus on teaching inquiry knowledge but also address teachers' core teaching conceptions to be successful (Lotter et al., 2007). Moreover, research has indicated that teachers' core teaching conceptions significantly influence their receptivity to inquiry-based teaching practices (Blanchard et al., 2008).

Incorporating technology into inquiry-based science classrooms has been recognized as a promising approach to engage students in scientific inquiry. Technology-enhanced inquiry tools have been proposed as a pedagogical framework to support teaching and learning in inquiry-based science classes (Kim et al., 2007). Additionally, technology-enhanced scaffolds have been found to effectively support scientific inquiry in problem-solving contexts when accompanied by clear project goals, relevant evidence, assessments, and knowledge articulation (Kim & Hannafin, 2010).

## METHODOLOGY

### Research Design

The study will employ a mixed-methods research design, integrating quantitative surveys and qualitative data collection methods to provide a comprehensive understanding of the effectiveness of inquiry-based learning approaches.

**Population**

The population for this research consists of 117 senior secondary school teachers and 270 students in Jega local government area, Kebbi State, Nigeria.

**Sample and Sampling Techniques**

Twenty (25) teachers (15 males and 10 females) would be selected from the chosen schools for interview. Similarly, fifty (160) students would randomly be selected.

**Instrumentation**

Surveys will be administered to both teachers and students to collect quantitative data on engagement, critical thinking, and conceptual understanding. The surveys will include Likert-scale items and open-ended questions.

Focus group discussions and semi-structured interviews will be conducted with a subset of teachers, students, and school administrators to gather in-depth insights into their experiences and perceptions of inquiry-based learning.

**Procedure for Data Collection**

Surveys will be administered to teachers and students before and after the implementation of inquiry-based learning activities. The surveys will be distributed electronically or in-person, depending on the preferences of the participants.

Focus group discussions and interviews will be conducted with a purposive sample of teachers, students, and school administrators. These sessions will be audio-recorded and transcribed for qualitative analysis.

**Data Analysis:**

After data was collected, the researcher checked the completeness of the questionnaires. The responses were analyzed using basic descriptive statistics including frequencies and percentages using Statistical Package for Social Sciences (SPSS, Version 23).

## RESULTS

**Research Questions One:** *How does the implementation of inquiry-based learning methods affect students engagement level in science classroom?*

**Table 1 Summary of the implementation of inquiry-based learning methods affect students engagement level in science classroom**

| ITEMS | N | Mean | St. Deviation | Decision |
|---|---|---|---|---|
| I feel more engaged in science lessons when inquiry-based learning is used. | 185 | 2.05 | .686 | Rejected |
| Inquiry-based learning encourages me to actively participate in classroom discussions. | 185 | 2.15 | .813 | Rejected |
| I am more motivated to complete science-related tasks when using inquiry-based approaches. | 185 | 2.30 | .801 | Rejected |
| Inquiry-based learning improves my collaboration and interaction with peers. | 185 | 1.80 | .616 | Rejected |
| I find science lessons more interesting and enjoyable when inquiry-based learning is applied | 185 | 1.65 | .813 | Rejected |

Table 1 data shows that mean set scores ranging between 1.65 and 2.30 which were above the criterion mean 1.65 therefore indicates that the respondents rejected the results while 2.50 and therefore indicates that the respondents accepted that there is no impacts of To examine the implementation of inquiry-based learning methods affect students engagement level in science classroom. This means that there in need for the factors hindering the implementation of inquiry-based learning methods affect students engagement level in science classroom. It promotes innovation and creativity among students and it provides a good teaching practice to the students and teachers.

**Research Questions Two** *What is the contribution of inquiry-based learning approach to the development of critical thinking skills among secondary schools students?*

**Table 2: Summary of contribution of inquiry-based learning approach to the development of critical thinking skills among secondary schools students.**

| ITEMS | N | Mean | St. Deviation | Decision |
|---|---|---|---|---|
| Inquiry-based learning improves my ability to analyze scientific problems critically. | 185 | 2.05 | .686 | Rejected |
| I am better able to evaluate different sources of scientific information using inquiry-based learning. | 185 | 2.15 | .813 | Rejected |
| Inquiry-based learning helps me develop problem-solving skills in science. | 185 | 2.30 | .801 | Rejected |
| I feel more confident in questioning and challenging scientific concepts due to inquiry-based learning. | 185 | 2.40 | .821 | Rejected |
| Inquiry-based learning enhances my ability to apply logic and reasoning in science experiments | 185 | 1.80 | .616 | Rejected |

Table 2 data shows that mean set scores ranging between 1.80 and 2.40 which were above the criterion mean 1.80 therefore indicates that the respondents rejected the results while 2.50 and therefore indicates that the respondents accepted that there is no impacts of contribution of inquiry-based learning approach to the development of critical thinking skills among secondary schools students. This means that there in need for the factors hindering the contribution of inquiry-based learning approach to the development of critical thinking skills among secondary schools students. It promotes innovation and creativity among students and it provides a good teaching practice to the students and teachers.

**Research Questions Three** *In what ways does inquiry-based learning enhanced students conceptual understanding of scientific concepts?*

**Table 3: Summary of inquiry-based learning enhanced students conceptual understanding of scientific concepts**

| ITEMS | N | Mean | St. Deviation | Decision |
|---|---|---|---|---|
| Inquiry-based learning deepens my understanding of scientific principles. | 185 | 1.45 | .510 | Rejected |
| I can better explain and apply scientific concepts after participating in inquiry-based learning activities. | 185 | 2.70 | .470 | Accepted |
| Inquiry-based learning helps me connect scientific theories to real-world applications. | 185 | 2.30 | .801 | Rejected |
| I retain scientific knowledge for a longer period when I learn through inquiry-based methods. | 185 | 1.80 | .616 | Rejected |
| Inquiry-based learning encourages me to explore scientific concepts beyond the classroom. | 185 | 1.65 | .813 | Rejected |

Table 3 data shows that mean set scores ranging between 1.65 and 2.70 which were above the criterion mean 1.80 therefore indicates that the respondents rejected the results while 2.50 and therefore indicates that the respondents accepted that there is no impacts of inquiry-based learning enhanced students conceptual understanding of scientific concepts. This means that there in need for the factors hindering the impact of inquiry-based learning enhanced students conceptual understanding of scientific concepts. It promotes innovation and creativity among students and it provides a good teaching practice to the students and teachers.

**Research Question Four:** *What is the relationship between the utilization of inquiry-based learning methods and students performance in science education in secondary schools?*

**Table 4: Summary of the relationship between the utilization of inquiry-based learning methods and students performance in science education in secondary schools.**

| ITEMS | N | Mean | St. Deviation | Decision |
|---|---|---|---|---|
| Inquiry-based learning has positively influenced my academic performance in science. | 185 | 2.05 | .686 | Rejected |
| I perform better on science assessments when inquiry-based methods are used. | 185 | 2.15 | .813 | Rejected |
| Inquiry-based learning helps me apply scientific concepts more effectively in tests and projects. | 185 | 2.40 | .821 | Rejected |
| I have improved my scientific reasoning and experimental skills through inquiry-based learning. | 185 | 2.70 | .470 | Accepted |
| My grades in science have improved due to the use of inquiry-based learning approaches | 185 | 2.30 | .801 | Rejected |

Table 4 data shows that mean set scores ranging between 2.05 and 2.70 which were above the criterion mean 2.05 therefore indicates that the respondents rejected the results while 2.50 and therefore indicates that the respondents accepted that there is no impacts on the relationship between the utilization of inquiry-based learning methods and students performance in science education in secondary schools. This means that there in need for the factors hindering the impact relationship between the utilization of inquiry-based learning methods and students performance in science education in secondary schools. It promotes innovation and creativity among students and it provides a good teaching practice to the students and teachers.

## DISCUSSION OF FINDINGS

The investigation into the effectiveness of inquiry-based learning (IBL) approaches in promoting student engagement, critical thinking, and conceptual understanding in secondary school science classrooms reveals a multifaceted impact on educational outcomes. IBL encourages students to actively participate in their learning processes, which significantly enhances their engagement and motivation. For instance, Cairns emphasizes that inquiry-based instructional practices foster scientific knowledge through hands-on experimentation, which is crucial for developing a deep understanding of scientific concepts Cairns (2019). This aligns with findings from Baldock and Murphrey, who report that inquiry-based lessons improve students' scientific reasoning abilities, thereby enhancing overall engagement in science education (Baldock & Murphrey, 2020).

Critical thinking is another area where IBL demonstrates substantial effectiveness. Worachak et al. highlight that inquiry learning models allow students to engage in critical thinking by requiring them to analyze information, make decisions, and draw conclusions based on evidence (Worachak et al., 2023). This is supported by Akuma and Callaghan, who note that teachers' perceptions of inquiry as a means of experiential learning can significantly influence the implementation of inquiry strategies in the classroom, thereby fostering an environment conducive to critical thinking (Akuma & Callaghan, 2018). Furthermore, Lazonder and Harmsen's meta-analysis confirms that guided inquiry learning positively affects students' performance and learning outcomes, reinforcing the notion that structured inquiry fosters critical thinking skills (Lazonder & Harmsen, 2016).

In terms of conceptual understanding, the literature indicates that IBL is particularly effective in helping students grasp complex scientific concepts. For example, Kollöffel and Jong demonstrate that combining traditional instruction with inquiry learning in virtual labs leads to better conceptual understanding than either method alone (Kollöffel & Jong, 2013). This finding is echoed by Demaria et al., who report that inquiry-based learning enhances scientific literacy and retention, which are essential for deep conceptual

understanding (Demaria et al., 2019). Additionally, the work of Pedaste and Altin suggests that inquiry-based education, particularly when integrated with robotics, can significantly improve learners' inquiry skills and subject knowledge, further supporting the development of conceptual understanding in science (Pedaste & Altin, 2020).

Moreover, the integration of technology in IBL has been shown to enhance engagement and facilitate inquiry processes. For instance, the use of social media in inquiry-based learning environments has been found to positively impact student engagement by providing platforms for communication and collaboration (Mardiana, 2017). This technological integration aligns with the findings of Sypsas et al., who emphasize the importance of well-designed instructional strategies in virtual laboratory environments to maximize the benefits of inquiry learning (Sypsas et al., 2020).

In conclusion, the findings from various studies underscore the effectiveness of inquiry-based learning approaches in promoting student engagement, critical thinking, and conceptual understanding in secondary school science classrooms. The combination of hands-on experimentation, guided inquiry, and technological integration creates a rich learning environment that fosters deeper learning and scientific literacy among students.

## CONCLUSION

The findings of this study highlight the challenges and limited impact of inquiry-based learning (IBL) methods on student engagement, critical thinking, conceptual understanding, and academic performance in secondary school science education. The data collected from the respondents indicate that students do not perceive IBL as significantly enhancing their learning experiences. Despite the theoretical and research-based advantages associated with IBL, such as fostering engagement, improving problem-solving skills, and strengthening conceptual understanding, the rejection of these impacts in this study suggests potential hindrances in the implementation process.

Several factors may contribute to this discrepancy, including inadequate teacher preparation, lack of necessary resources, and resistance to adopting student-centered pedagogical approaches. These barriers may limit the effectiveness of IBL in real classroom settings, preventing students from fully benefiting from its intended advantages. Therefore, addressing these challenges is crucial for maximizing the potential of inquiry-based instruction in science education.

Moreover, the literature review supports the effectiveness of IBL when implemented with proper guidance, technological integration, and structured instructional strategies. Studies by Cairns (2019), Baldock and Murphrey (2020), and Worachak et al. (2023) indicate that IBL fosters deeper scientific understanding and critical thinking. However, the findings of this study suggest that, in the context of secondary schools examined, IBL has not yet achieved its full potential.

To improve the effectiveness of inquiry-based learning in science education, educators and policymakers should focus on overcoming the barriers to implementation. This includes providing professional development for teachers, ensuring access to necessary instructional resources, and fostering an environment that encourages active student participation. Additionally, integrating technology into IBL strategies may enhance engagement and facilitate inquiry processes.

In conclusion, while IBL has the potential to significantly enhance science education, its impact in the studied secondary school settings remains limited due to various implementation challenges. Future research should explore ways to address these barriers and develop more effective strategies for integrating IBL into science curricula to achieve better educational outcomes.

## RECOMMENDATIONS

The researchers come with the following recommendations:

1. Schools and educational authorities should organize regular workshops and training sessions to equip teachers with the necessary skills and knowledge to implement IBL effectively.
2. Governments and school administrations should provide adequate resources, including laboratory equipment, instructional materials, and digital tools, to support inquiry-based learning.

3. Teachers should adopt strategies to actively involve students in IBL processes, such as collaborative learning, real-world problem-solving, and project-based assessments.
4. Schools should leverage digital tools, online simulations, and virtual laboratories to enhance the inquiry-based learning experience.
5. A continuous assessment mechanism should be established to monitor the effectiveness of IBL and make necessary adjustments based on student performance and feedback.

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