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Original Article

Comparing the Relative Predictive Strength of Guided and Open Inquiry in Enhancing Students' Physics Achievement Scores and Physics Project Performance

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ABSTRACT

Inquiry-Based Learning has been shown to affect students' academic achievements, including achievement scores, practical and project works, self-efficacy, and students' attitudes. Achievement scores are a better indicator of the level of conceptual understanding in a given subject. This research presents how open and guided approaches to inquiry enhance students' physics achievement scores, and how guided inquiry is a better indicator of the students' Physics achievements. A total of 176 students and 6 teachers were purposively selected from the target population. A quasi-experimental design was used in the study. Data was collected by Physics Achievement Tests (PAT) that were extracted from the past K.C.S.E. physics papers. The test-retest technique was used to test the reliability of the test items. SPSS version 25 was used to analyse the data collected, computing the means, standard deviations, paired sample statistics, independent samples t-tests, and ANCOVA. The results revealed that the experimental group that was instructed by open inquiry improved from a mean score of 68.538 to 72.138, giving a gain score of +3.600, while the control group that was instructed by guided inquiry improved from a mean score of 32.000 in the pretest to 69.333 in the posttest, giving a gain score of +37.333. The ANCOVA test revealed that the higher mean score of the experimental group in the posttest was due to the baseline imbalances witnessed at the start of the study.

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INTRODUCTION

Given the ongoing focus by curriculum developers on teaching methods that involve inquiry, assessing the effectiveness of different levels of inquiry remains a significant issue, especially in science education (Nzomo et al., 2023). If the effectiveness of inquiry-based learning is as accurate as reported by various researchers, then scholars should determine its impact on specific learning outcomes (Bernido, 2020). Nzomo et al. (2023) noted that although many studies have documented the effectiveness of IBL, most of their reports are based on research settings rather than typical classroom environments. Several scholars have different definitions of inquiry learning, but they all agree that inquiry learning refers to a process where students actively seek knowledge while teachers facilitate the search (Bernido, 2020). The teacher creates an enabling environment for students to explore knowledge instead of being the sole source of information. Based on the level of teacher involvement in students' inquiries, IBL can be classified as confirmatory, structured, guided, or open (Bansiong, 2023). According to Bansiong, confirmatory inquiry involves learners being provided with both the question under investigation and the procedures for solving it, and the solution; their role is to validate the solutions. Structured inquiry, on the other hand, provides students with the problem and procedures but not the solutions, so students must discover the solutions independently. In guided inquiry, instructors develop the inquiry questions, and students devise procedures and solutions to solve the problems. In open inquiry, students are only given background knowledge related to the concept of inquiry, but are responsible for formulating questions, developing procedures, and finding solutions on their own.

Inquiry-based learning approaches have gained global recognition as a response to the challenges of dismal physics achievement, often described as learner-centred and capable of enhancing students' participation, conceptual mastery, and higher-order thinking skills. Recent studies have shown that IBL can lead to significant improvements in students' academic achievement, problem-solving skills, and self-efficacy in Physics (Rizki et al., 2024; Misoga et al., 2024). However, while these studies generalise the effectiveness of IBL, they do so while treating IBL as a whole unit, with little differentiation between its components, such as guided and open inquiries. Although both guided and open inquiries are based on constructivist learning theory, they differ significantly in terms of their structure and the cognitive demands they pose on learners. As instructors provide systematic support to the learners in the course of the inquiry in guided inquiry, support in open inquiry is diminished as learners are more autonomous in deciding the trajectory of their inquiry.

Physics assessment in Kenya is done in two phases. The first phase comprises papers 1 and 2, which test theoretical mastery, while the second phase, which has paper 3, tests practical skills. Both papers 1 and 2 can have objective and subjective tests that need short answers and explanations. These questions normally test the conceptual understanding of students. On the other hand, paper 3 involves the manipulation of the apparatus and the making of observations. For the study conducted herein, achievement scores were used to refer to the students' attainments in

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papers 1 and 2, while project performance was used to refer to the students' attainments in the hands-on activities.

According to Bernido (2020), several studies have recorded the effectiveness of guided inquiry in improving student learning in learning environments. Auli et al. (2018), as cited in Bernido (2020), pointed out that integrating guided inquiry led to an increase in N-gain scores in students' science literacy.

The 5E model developed by the Biological Sciences Curriculum Study (BSCS) guides IBL sessions. The name derives from the first letters of the five stages: engage, explore, explain, elaborate, and evaluate (Thangjai & Worapun, 2022). In the engagement phase, the teacher assesses students' prior knowledge and misconceptions about the topic. During the study, the researcher and the physics teachers evaluated students' prior knowledge of refraction of light and their major misconceptions, primarily through oral questions. In the exploration phase, learners practised process skills such as observing, questioning, investigating, testing hypotheses, and discussing with peers. The explanation phase gives students time to share their findings, understandings, and challenges before the teacher provides clarification. The researcher and subject teacher allowed students to present their findings before offering detailed explanations. In the elaboration stage, students are expected to apply their newly acquired knowledge to new contexts, such as developing artefacts and models. For instance, students during the study created projects applying concepts related to light refraction. The evaluation phase, which is the fifth stage, involves assessing the changes in performance resulting from the intervention and learning. In IBL classes, evaluation is ongoing and provides feedback for further instruction. As the session progressed, instructors observed students working in groups as they sought knowledge and engaged in peer assessments. Additionally, instructors evaluated students' projects using analytical rubrics (Duran & Duran, n.d.).

Cai et al (2021) qualitatively analysed transcribed audio for a physics laboratory session to identify which between open and guided inquiry would lead to better physics performance. The laboratory sessions were done by second-year undergraduate physics students. 8 pairs of students conducted open inquiry, while 5 pairs conducted guided inquiry. Their study revealed that students in the guided group mainly concentrated on adhering to the procedures given for the completion of the work, while those in the open inquiry explored a range of alternatives, which enhanced their creativity and critical thinking. Additionally, whenever the investigation did not come out as prescribed for the students under guided inquiry, it was observed that they became confused and frustrated. On the contrary, students under open inquiry embraced the challenges encountered and used them as opportunities to configure and troubleshoot their tools and procedures (Cai et al., 2021). However, the foregoing study analysed transcribed audio for data collection. The current study used validated data collection tools such as laboratory rubrics and physics achievement tests to collect data.

Researchers employed a quasi-experimental design to compare the effectiveness of structured, guided, and open inquiry for classroom implementation in Indonesia. The study targeted students who were being trained at the University of Mataram as elementary school teachers (Artayasa et al., 2018). The researchers used a cluster random sampling technique to sample 154 students for the study. The Science Concept Test was the major instrument for data collection. The study findings revealed that students who conducted open inquiries had the greatest improvement in understanding science concepts (Artayasa et al., 2018). The researchers attributed this greater improvement to students' effort in preparation, literature searching, comprehending the procedures, and variable manipulation. In addition, the responsibility given to the learners to take full lead over their work made them think widely, logically, and more scientifically. Guided and structured inquiries were reported to be solving only questions generated and presented by

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the lecturer to the students, unlike in open inquiry, where the rigorous development of research questions and search for solutions make learners more competent in the field of inquiry (Artayasa et al., 2018). This study in Indonesia was conducted at a tertiary level of learning. The current was done in a secondary school setup.

Mbata et al (2025) compared the four levels of inquiry to determine which one was the best in physics instruction to enhance the mastery of practical skills. The researchers selected 82 students who were in their ordinary level in Tanzanian secondary schools. The researchers purposively sampled two schools that had similar characteristics. Data collection instruments were physics practical, practical skills observation rubric, and lab worksheets. Constructivist learning theory was the theoretical framework that guided the study of Mbata et al (2025). The results of their quasi-experimental design revealed that the two most structured levels at the lowest levels of inquiry, that is, confirmatory and structured, where students are given both the research question and procedures, do not form part of inquiry, but rather traditional-based experiment (TBE). They argued that the next two levels, which are guided and open inquiries, are the major types of inquiry learning in the sciences. Open inquiry was criticised for being too difficult to translate into real classrooms and being too abstract for students, especially the novice, to formulate sensible research problems. Mbata et al (2025) concluded by emphasising guided inquiry for its ability to develop practical skills among learners. Their criticism of confirmation and structured levels was that they lead to rote memorisation and replication of procedures, without developing rigorous practical skills in Physics. The study by Mbata et al (2025) was guided by constructivist theory alone. The current one employed constructionist learning theory, in addition to the constructivist learning theory.

Despite the KICD's recommendation of inquiry-based strategies for instruction under the new competence-based education (CBE), physics achievement has remained low in both internal and external exams (Kunga, 2021; KNEC, 2017-2022). Moreover, studies in Kenya and internationally on IBL's relevance in enhancing conceptual understanding among STEM students have shown inconsistent results. Wang et al. (2022) urge researchers to closely examine which specific approach to IBL yields the most positive outcomes in students' achievements in STEM fields. They argue this will help resolve ongoing debates about which level of inquiry is most suitable for secondary students, considering resource, time, and learning experience limitations in classrooms.

Rationale of the Study

Students have persistently underperformed on both standardised physics tests and hands-on assessments that include practical work and projects. This continued underperformance necessitates adopting instructional approaches that go beyond conventional teacher-centred methods toward heuristic models that centre on learners rather than instructors. Several studies have shown that inquiry-based learning (IBL) can enhance students' conceptual understanding, problem-solving skills, creativity, and critical thinking. However, IBL is not a uniform construct but rather comprises several components that vary with the level of instructors' involvement in students' inquiries. For instance, guided inquiry and open inquiry differ in structure, the degree of learners' autonomy, and the demands they place on students' mental processes. While open inquiry tends to be less structured, leaving students more independent in designing and conducting investigations, guided inquiry offers learners scaffolding in designing and implementing inquiries.

Despite these differences, early researchers have largely studied these two approaches independently, limiting comparative insights into their relative effectiveness. The limited literature comparing the two approaches, therefore, justifies this study, which seeks to clarify and present how the predictive strength of guided inquiry and open inquiry in enhancing students' achievement on

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physics tests and project performance compares. Furthermore, contemporary education systems, Kenya's competency-based education (CBE) being one of them, have emphasised the attainment of hands-on competencies, the ability to apply knowledge, and learner autonomy. Students' performance in physics projects is a crucial indicator of such competencies, yet it remains understudied, as most empirical studies have focused on examination scores. By concurrently studying achievement and project performance, this study contributes to the growing need for a holistic evaluation of learning. In addition, the study's predictive aim goes beyond simply determining the effect of each inquiry approach and is expected to generate evidence-based findings that will inform teacher training, curriculum design, and instructional practices, thereby aligning physics education with contemporary educational standards.

Statement of the Problem

Physics education is so pivotal in developing scientific skills, including problem-solving skills and critical thinking skills, necessary for advancing the technological sector. But despite its significance, Physics achievement in both examination scores and project performance continues to be alarming globally, and even in the African context, including Kenya. Available studies have shown that learners have often demonstrated low achievement levels and minimal ability to transfer physics concepts into real-world contexts, a condition that has largely been attributed to the reliance on expository instructional strategies that are teacher-centred (Okeke & Ramaila, 2025).

Existing studies have mostly studied the effectiveness of guided and open inquiry independently, often overlooking the comparative analysis of their relative effectiveness. Furthermore, most of the studies dwelt on the achievement scores while neglecting the physics project performance, a crucial aspect of applied learning and competency development. Additionally, there exist limited studies that simultaneously examined the predictive strength of the two inquiry approaches on physics achievement scores and physics project performance. This gap creates uncertainty among physics educators and curriculum developers regarding which approach to inquiry leads to higher learning outcomes across cognitive and psychomotor domains. Therefore, this study aims to compare the relative predictive strength of guided and open inquiry approaches in enhancing students' physics achievement scores and physics project performance, with the intention of providing evidence-based guidance for instructional practice and curriculum design.

Specific Objective

To compare the relative predictive strength of guided and open inquiry in enhancing students' physics achievement scores and project performance.

Research Hypothesis

There is no statistically significant difference in the predictive strength of guided and open inquiry in enhancing students' physics achievement scores and project performance.

LITERATURE REVIEW

Inquiry-based learning (IBL) has been widely recognised as a contemporary pedagogical strategy that enhances active learning, critical thinking, and conceptual understanding in STEM education. Education systems have shifted globally from teacher-centred approaches to learner-centred approaches that emphasise exploration, questioning, and reasoning based on evidence. Recent studies have shown that IBL enhances students' academic achievements through subjecting learners to authentic problem-solving and experimental processes (Siantuba et al., 2023; Papalazaraou et al., 2024). These approaches are rooted in the constructivist learning theories, which emphasise the learner's active role in constructing knowledge through interaction with the environment. Consequently,

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many developing and developed countries have adopted IBL into physics education as a strategy to improve its achievement.

At the global stage, guided inquiry has emerged as a structured form of inquiry-based learning that offers scaffolding to learners as they develop scientific understanding. In guided inquiry, the teacher facilitates students' inquiry through prompts, guided questioning, and structured experiments. Available literature has provided that this approach enhances students' conceptual understanding and general academic achievement in physics, especially for students who need facilitation in navigating the inquiry process of the abstract physics concepts (Simbolon & Silalahai, 2023; Pascaeka et al., 2023). Additionally, empirical evidence has shown that the supportive environment nature of guided inquiry that strikes a balance between autonomy and guidance improves students' scientific reasoning and attitudes toward science. However, the opponents of guided inquiry argue that too much guidance can limit students' independent thinking and creativity, thereby retarding the growth of higher-order thinking skills among learners.

In contrast, the less structured nature of open inquiry gives learners a higher percentage of independence and responsibility over the course of their learning. In open inquiry, learners independently formulate the inquiry questions, design and implement the experiments, and interpret the results. Globally, open inquiry has been linked to the development of higher-order thinking skills such as creativity, critical thinking and independent problem-solving skills. Nisa et al. (2023) asserted that learners in open inquiry demonstrate higher abilities of transferring learned knowledge to real-world contexts and exhibit higher levels of motivation and engagement. However, the effectiveness of open inquiry is largely dependent on students' prior knowledge and their cognitive readiness, and may disadvantage novice students with little prior knowledge on the topic of inquiry. Such students may exhibit superficial knowledge and misconceptions on the topic of inquiry.

African countries, in the quest to reform science education the ongoing education reforms have adopted IBL strategies in the classroom instructions. Most of the countries in Africa are shifting to heuristic pedagogies with the aim of addressing the persistent low performance in the STEM disciplines. Okeke & Ramaila (2025) pointed out that studies conducted in the Sub-Saharan regions in Africa showed that IBL strategies not only boost students' mastery of physics concepts, but also enhance their engagement in physics classes. But their classroom implementation is restricted by contextual factors, including large class sizes, limited instructional materials, and inadequate teacher training.

Guided inquiry has experienced a wide adoption in African countries due to its structure that matches the already used classroom approaches while gradually introducing learner-centred components. According to Misoga et al. (2024), guided inquiry is most effective when instructing novice learners who lack the prerequisite knowledge and skills for independent inquiry. Despite guided inquiry's ability to enhance the development of the basic essential knowledge, it may not fully enhance the development of independent inquiry skills and innovation, which are critical components of the contemporary systems of education.

Though several countries in Africa haven't yet adopted open inquiry into classroom instruction, studies indicate that it leads to the development of higher-order thinking skills, through the scientific explorations it exposes learners to and the autonomy it grants the learners to take full responsibility for their learning. Likewise, to the situation with guided inquiry, its implementation is impeded by inadequate teacher training, limited instructional resources, and the curriculum demands that are examination-oriented. Thus, researchers ought to study how open inquiry can be implemented in African classes, given the constraints, without compromising the learning outcomes.

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The recently rolled out Competency-Based Curriculum (CBC) in Kenya emphasised the adoption of learner-centred teaching approaches, including IBL, and the acquisition of hands-on competencies. Physics, being a practical subject, under the CBC framework, prioritises both conceptual understanding and the ability to transfer knowledge to real-world contexts to solve real-life problems. Studies indicate that learners in Kenya still struggle to transfer physics knowledge to real-world contexts, as reflected in their continued low physics achievement scores and project performance (Misoga et al., 2024). This justifies the need for more insightful instructional strategies that can bridge the gap between theory and practice.

Although the Kenya Institute of Curriculum Development (KICD) has recommended inquiry-based learning approaches, the existing studies have addressed the effectiveness of the IBL approaches in general without differentiating the various IBL approaches. There is limited empirical evidence that compares the relative predictive strength of guided and open inquiry in enhancing both physics achievement scores and project performance. Moreover, most of the studies prioritised the achievement scores, while overlooking the project performance aspect, which is a crucial component of CBC.

There is, therefore, a disconnect between the available literature and the comparative predictive strength of guided and open inquiry in enhancing students' physics achievement scores and project performance. Bridging the disconnect is essential for informing instructional practices, teacher training, curriculum design and implementation in both Kenya and similar contexts. Therefore, the study embarked to bridge the gap by providing empirical evidence on the comparison of the predictive strength of guided inquiry and open inquiry in enhancing students' physics achievement scores and project performance.

RESEARCH METHODOLOGY AND DESIGN

This study adopted a Quasi-experimental Solomon's Four-Group Non-Equivalent Control Design. This design enabled the determination of causal relationships between IBL and students' physics achievement, including assessing whether the effects on the physics achievement result from the interaction between pre-test and treatment (Kunga, 2021). Furthermore, with this design, it was possible to identify two comparable groups with similar characteristics. A total of 176 students were sampled from the four schools that participated in the study. Since school authorities often do not permit reconstituting intact classes for research, two of the sampled schools' physics classes were randomly assigned as experimental groups, while the remaining two served as control groups. One of the control groups took a pretest before being instructed by guided inquiry, and after the intervention, they took a posttest. The other control group did not take a pretest, as this was a strategy used to reveal any relationship between the pretest and the intervention.

Approval for data collection was obtained from Murang'a University of Technology Institutional Scientific and Ethics Review Committee (ISERC) and the National Commission for Science, Technology and Innovation (NACOSTI). The researcher upheld integrity by clearly describing the research title and the purpose of the study in both the consent and assent forms to ensure the aim of the study was clear to both the authorities and the respondents before choosing to take part in the study. The researcher also allowed respondents to voluntarily join the study after assuring them of the confidentiality of their information. The school principals filled out consent forms while the students completed assent forms to indicate their agreement to participate in the study. The students' responses were accessed only by the researcher and the research attendants. All the consulted sources were cited.

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RESULTS AND DISCUSSIONS OF THE STUDY

The study set out to compare the relative predictive strength of guided and open inquiry in enhancing students' physics achievement scores and physics project performance. A total of 176 students took part in the study. 88 of them took a pretest before the intervention. The students in the experimental group were then instructed by open inquiry, while those in the control group were instructed by guided inquiry, up to the completion of the refraction of light, which was the topic for the study. All the students then took a post-test. The findings were as discussed.

To determine which, between guided and open inquiry, was a stronger predictor of students' physics achievement scores, the descriptive statistics for both the pretest and the posttest were sought.

Table 1: Descriptive Statistics for the Pretest

	Category	N	Minimum	Maximum	Mean	Std. deviation	Std. Error Mean
pretest	Experimental group one, E1	53	50	85	68.538	8.2105	1.1278
	Control group one, C1	35	15.0	52.5	32.000	10.3164	2.6637

Source: *Researcher, 2026*

The results showed that in the pretest, the experimental group that was to be instructed by open inquiry outperformed their colleagues in the control group, who were scheduled to receive instruction by guided inquiry. Hence, before the intervention, it was evident that the experimental group was a higher achiever than the control group. An independent Sample t-test for pretest mean score for the two groups was run to determine whether the difference in the score was statistically significant.

Table 2: The Independent Sample t-test for the Pretest Mean Score of the Physics Achievement Test for the Pretest

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Score	**Equal variances assumed**	36.321	.000	5.533	109	.000	17.0757	3.0863	10.9587	23.1927
	Equal variances not assumed.			5.696	82.345	.000	17.0757	2.9976	11.1128	23.0385

Source: *Researcher, 2026*

The results showed that the assumption of equal variances was 5.533, while that for the assumption of unequal variances was 5.696, with 109 and 82.345 as their respective degrees of freedom. The significance level obtained was .000, which is lower than the established threshold of 0.05. Therefore, the difference in performance between the experimental and the control group was statistically significant, and it is evident that the experimental group was generally a higher-achieving group than the control group at the beginning of the study. A posttest was administered to both groups, and paired sample

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statistics were calculated separately for the two groups.

Table 3: Paired Sample Statistics for the Experimental Group 1

		Mean	N	Std. Deviation	Std. Error Mean
Pair	PRETEST	68.538	53	8.2105	1.1278
	POST	72.138	53	9.5846	1.3165

The results indicated that the students' achievement in the posttest improved from a mean score of 68.538 with a standard deviation of 8.2105 to a mean score of 72.138 with a standard deviation of 9.5846 in the posttest. Hence, after the intervention, the students experienced a gain score of +3.6. A Paired Samples Test was run to determine whether the improvement was statistically significant.

Table 4: Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	**PRETEST-POST**	-2.690	52	.010

Source: *Researcher, 2026*

The t-value obtained was -2.690, with 52 degrees of freedom and a significance level of .010. Since the significance level obtained is lower than the established level of 0.05, the result of the intervention is statistically significant. That is, the students' physics achievement scores improved significantly after the intervention. Therefore, open inquiry led to some improvement effect on the students' physics achievement scores. The paired samples statistics for control group 1 were also determined after the administration of the posttest, having undergone the guided inquiry.

Table 5: Paired Samples Statistics for Control Group 1

		Mean	N	Std. Deviation	Std. Error Mean
Pair	**Pretest**	32.000	35	10.3164	2.6637
	Posttest	69.333	35	16.9664	4.3807

Source: *Researcher, 2026*

The results for the control group also showed that students experienced an improvement effect from the mean score of 32.000 with a standard deviation of 10.3164 in the pretest to a mean score of 69.333 with a standard deviation of 16.9664 in the posttest. This showed that the students experienced a gain score of +37.333 after undergoing the intervention. A paired sample test was also run for the control group to determine whether the improvement was statistically significant.

Table 6: Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PRETEST-POST	-11.914	34	.000

Source: *Researcher, 2026*

The above table shows that the t-value for the result was -11.914 with 14 degrees of freedom and a significance level of .000. Since the significance level is lower than the established level of 0.05 ($0.000 < 0.05$), the improvement after the intervention was statistically significant.

Though the mean score in the posttest for the group that was instructed by open inquiry (72.14)

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was higher than that of the group instructed by guided inquiry (69.33), in light of the gain scores, it is not reliable to conclude that open inquiry had a higher improvement effect on the achievement scores than the guided inquiry. The gain score for the group that received open inquiry was +3.6, while that for the control group instructed by guided inquiry was +37.333. The higher gain score experienced among the control group students justifies the conclusion that guided inquiry was a stronger predictor of students' physics achievement scores than open inquiry.

Additionally, for the control of baseline imbalances experienced at the beginning of the study, an ANCOVA test was run.

Table 7: Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6538.295	2	3269.148	39.701	.000	.562
Intercept	1752.787	1	1752.787	21.286	.000	.256
Pretest	1925.402	1	1925.402	23.382	.000	.274
Group	137.401	1	137.401	1.669	.201	.026
Error	5105.385	82	82.345			
Total	306751.909	85				
Corrected Total	11643.680	84				

Source: *researcher, 2026*

The results showed that the difference between the mean scores for the experimental and the control groups was not statistically significant (P = .201), and hence the higher mean score achieved by the group that received open inquiry was attributed to their high initial achievement witnessed at the beginning of the study. Therefore, going by the higher gain score attained by the guided inquiry than the open inquiry group, it was concluded that guided inquiry was a stronger predictor of students' physics achievement scores than open inquiry.

Further, the study aimed to identify a stronger predictor of students' physics achievement scores between guided and open inquiry approaches. The results indicated that guided inquiry was a more effective predictor of students' physics achievement than open inquiry. This finding contradicted many earlier studies, which suggested that open inquiry is a better predictor of physics achievement than guided inquiry. For example, Guisti (2008), in his study comparing short-term and long-term gains in students' physics scores between guided and open inquiry in America, found that both methods improved achievement scores, but open inquiry led to larger gains. Artayasa et al. (2018) also reported results that conflicted with this study. Their quasi-experiment in Indonesia, which examined which of four levels of inquiry most effectively improved students' understanding of science concepts, showed that students engaged in open inquiry experienced the greatest improvement, as reflected in their scores. Similarly, a quasi-experiment in Osun State, Nigeria, assessed the impact of guided and open inquiry on senior secondary one (SS1) biology students' achievement. While both groups improved, the open inquiry group's gains were significantly higher. Proponents of open inquiry argue that in open inquiry, students explore various options, which enhances their creative and critical thinking (Cai et al., 2021). Artayasa et al. (2018) also noted that the effort students put into searching literature, formulating questions, and designing procedures gives them ample time to understand concepts. However, the results of this study align with some earlier research. Mbata et al. (2025), in their non-equivalent quasi-experimental study in Tanzania, favoured guided inquiry over other approaches. They argued that confirmatory and structured inquiry methods are highly structured and rooted in the traditional instructional

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strategies, criticising open inquiry for being too abstract and difficult to implement in classrooms, especially among novice students or in mixed-ability classrooms. According to these researchers, guided inquiry provides students with learning opportunities while still offering some instructor support. Antonio & Prudente (2024) also advocated for guided inquiry, citing research that confirms its effectiveness and arguing that it surpasses other inquiry levels because it offers appropriate scaffolding while granting learners autonomy and responsibility. This was evident during the teaching process. Students engaged in open inquiry sometimes felt confused and discouraged when they couldn't formulate correct questions or procedures. Conversely, students in guided inquiry remained motivated to explore, including average and low-achieving students, as they received guidance on how to reach solutions. When they encountered difficulties, they sought assistance, which encouraged further searching.

CONCLUSION

It was concluded that both guided and open inquiry have improvement effects on students' physics achievement scores, but guided inquiry led to a higher improvement than open inquiry. The researcher identified that, inasmuch as students take responsibility for their learning in inquiry-based learning classes, scaffolding is necessary to reduce cognitive workload on students' working memory. The researcher recommends that future researchers verify the effectiveness of guided inquiry in improving achievement scores in other science subjects like biology and chemistry.

RECOMMENDATIONS OF THE STUDY

- Adoption of a blended inquiry approach in physics instruction.

Educators should integrate both guided and open inquiry approaches in physics instruction rather than adopting either of them. Guided inquiry can be useful in building foundational knowledge among novice learners who lack the prior knowledge to conduct independent inquiry, while open inquiry should be gradually implemented to enhance higher-order thinking and scientific skills, thereby enhancing both achievement scores and project performance.

- Capacity building and professional development for teachers.

Teachers should continuously be inducted on contemporary pedagogical skills necessary for the effective implementation of both guided and open inquiry. Training strategies should focus on designing physics inquiry classes, scaffolding strategies, assessing learning under inquiry classes, and managing inquiry classes with diverse learning abilities.

- Curriculum and assessment reforms to support inquiry-based learning

The bodies responsible for designing the curriculum and education policy makers should ensure alignment between the physics curriculum, assessment frameworks, and inquiry-based approaches by incorporating more hands-on assessments and real-world problem-solving tasks.

RECOMMENDATION FOR FURTHER STUDY

Since the researcher did not manage to fully exploit all the dimensions of IBL as an instructional strategy, the following recommendations were made for future research:

- The effect of IBL on students' engagement in integrated science lessons
- The students' attitudes toward IBL as a contemporary instructional strategy
- How the effect of IBL on Integrated Science project performance and achievement scores varies with class levels
- Whether IBL has an improvement effect on achievement scores and project performance in other learning areas like languages and Mathematics.

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