Inquiry-Based Learning For an Enhanced Students' Engagement And Critical Thinking Skills In Biology

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Abstract- *The aimed of this study is to determine the effectiveness of inquiry-based learning on students' level of engagement and critical thinking skills. The study used pre-experimental single group pretest-posttest design to grade 10 students from selected schools in the Division of Lipa City. Findings revealed that the level of behavioral engagement among student after the utilization of IBL was highly engaged. Likewise cognitive and emotional engagement among student was evident. Furthermore, students' level of critical thinking skills after the implementation of IBL were approaching proficiency. Lastly, significant differences were seen on students' level of engagement and critical thinking skills was seen after the implementation of IBL.*

Keywords- inquiry-based learning, behavioral engagement, critical thinking skills, biology.

I. INTRODUCTION

Science education in the Philippines is crucial for developing a populace that is knowledgeable in science and skilled in technology. The government, particularly the Department of Education (DepEd), acknowledges the necessity of enhancing the quality and availability of science education. Efforts have been made to improve scientific education by introducing the K-12 curriculum. The curriculum establishes precise criteria and competencies for science courses across several grade levels to offer a thorough basis in scientific knowledge and skills (Plasabas et al., 2020). The curriculum implementation's effectiveness and impact on student learning outcomes can vary throughout areas and schools due to differences in resources and capacities. The government has launched programs and projects to enhance science infrastructure, laboratory facilities, and instructional materials in schools. The K-12 curriculum prioritizes experiential learning, prompting students to participate in experiments, investigations, and scientific inquiry. These activities necessitate students to notice, question, and assess material critically. Students enhance their skills in data collection, analysis, pattern recognition, and logical reasoning through participation in scientific procedures. Science education enhances comprehension of the scientific process, which stimulates critical thinking by prompting students to question assumptions, challenge established knowledge, and provide alternative explanations (Wu et al., 2018).

Critical thinking is a fundamental ability of the 7C's of Education that 21st-century learners need to have. It has emerged as a significant area of interest and expertise in education at all levels. Its characteristics are interpretation, analysis, appraisal, inference, explanation, and self-regulation. Critical thinking is a higher-order thinking skill that may be taught through a comprehensive approach aimed at helping learners enhance their cognitive abilities using purpose-oriented learning models. Critical thinking is commonly utilized in Science lessons. Genetics students can observe their surroundings, form hypotheses to explain events, create experiments to test their predictions, and draw conclusions based on their study results.

Students' capacity to draw conclusions from activities is mostly based on their deductive reasoning skills. However, the application of relevant evidence to determine the reasons for a certain result relies more heavily on critical thinking. Furthermore, these pupils must possess the ability to develop ideas using inductive reasoning. This involves formulating broad generalizations drawn from specific data results. The arrangement of deductive and inductive reasoning serves as the foundation for the critical thinking necessary in biology and other science-related fields.

Over time, it has been evident that heredity is a challenging topic for students. It is equally challenging for both teachers and pupils. Educators in the country are concerned about the ongoing decrease in pupils' critical thinking skills. Academic experts relate these problems to educational institutions neglecting the development of students' critical thinking capacity (Wu et al., 2019). These previously mentioned issues drew the attention of numerous researchers and scholars to investigate the subject. Several research have been undertaken on various subjects in chemistry, as well as in biology, physics, and other scientific fields. Several studies suggest using Inquiry Based Learning (IBL) as a teaching approach to enhance critical thinking abilities and biology education in order to improve the current situation. IBL originated in the 1960s as part of the "discovery

learning" movement, which posits that individuals can learn by exploring circumstances, solving problems, and engaging in social interactions.

Students are encouraged to perform studies to fulfill their curiosity, which helps them expand their knowledge base and build their skills and conceptual frameworks, rather than memorizing material. IBL is a process that can enhance learners' intellectual engagement and deep understanding by encouraging them to develop questioning, research, and communication skills, collaborate in and out of the classroom, solve problems, create solutions, address real-life questions and issues, and contribute to the development and improvement of ideas and knowledge.

IBL involves various sequential phases. The initial process involves questioning, followed by exploring different scenarios, conducting analysis and giving descriptions, communicating findings vocally or in writing, and finally, reflecting on the acquired information and knowledge. Inquiry-based learning is also guided by numerous principles (Erbas &Ozsoy, 2018). The first principle emphasizes placing learners at the center of the process, with instructors, resources, and technology effectively arranged to assist them (Tolentino, 2021; Panoy et al., 2022). Learning activities are centered on information-processing abilities as the second principle (Tuckman & Kenedy, 2018). The third principle focuses on teachers facilitating the learning process while also aiming to understand more about their students and the inquiry-based learning process. The last principle emphasizes measuring the development of information-processing abilities and conceptual understanding rather than focusing on the actual substance of the field (Faraon et al., 2021). These tools are thought to enhance students' critical thinking skills when utilized in instruction. Four types of questions are typically employed in inquiry-based teaching. Learners are provided with a question and a method in confirmation inquiry if the outcome is already known. The objective is to verify the outcomes. Learners can strengthen existing concepts and enhance their inquisitive skills through this process (Jamias et al., 2021). The following is a structured inquiry approach in which learners are provided with a question and the way to achieve the outcome. The objective is to offer an explanation that is already backed by evidence collected during the investigative process. At the third level, learners are provided with a question in guided inquiry (Go & De Guzman, 2019). The primary objective is to develop the investigative approach and thereafter evaluate the research question (Ulu et al., 2021). This style of investigation is usually less organized than the ones outlined above. Finally, the open inquiries involve learners creating their own questions, developing investigative methodologies, and conducting the inquiry. They are required to showcase their findings at completion of the process.

In an educational environment, inquiry-based learning enables instructors to let students thoroughly investigate problems and situations, allowing them to learn from both the outcomes and the process itself (Marañon et al., 2019; Marquez & Rosario, 2022). They are prompted to inquire, investigate their surroundings, gather evidence to back up claims and findings, and construct a persuasive argument detailing their process leading to the final outcome (Sari et al., 2019).

Teachers are also responsible for facilitating learning. IBL is ineffective without students having a proportional desire to be engaged and participate in learning. Student engagement is a key factor here. Student engagement is essential for academic progress and achievement, as it significantly influences the learning process (Green et al., 2018; Strimel et al., 2020). Active student engagement fosters ownership of learning and enhances motivation for success. Engaged students are more prone to comprehending and retaining material, enhancing critical thinking abilities, and utilizing knowledge in practical scenarios (Rarugal et al., 2018). Students who are engaged are more likely to cultivate a favorable attitude towards learning, resulting in enhanced academic performance, increased graduation rates, and better post-secondary results. Student engagement is essential for ensuring that learning is impactful, significant, and pleasurable. By fostering participation in the classroom, teachers are enhancing academic achievement and cultivating lifelong learners.

The researcher links the use of inquiry-based learning (IBL) and engagement as a potential remedy to students' underperformance and the decrease in critical thinking. This research can enhance past teaching approaches and improve students' retention and overall performance, as suggested by Guzman & Santos (2018) and Sung et al. (2018). Modifying the approaches in the current teaching unit is expected to lead to a strong foundation of students' knowledge based on concepts (Dogomeo & Aliazas, 2022). This study aims to enhance students' comprehension and engagement by implementing Inquiry-Based Learning (IBL). The researcher also aimed for an enhancement in students' attitudes towards learning.

Background of the Study.This study was motivated by the observed decrease in critical thinking abilities and student involvement in science education in the Philippines. Prior research and academic studies have emphasized the

difficulties encountered by teachers and students in effectively cultivating critical thinking skills.

This study aims to explore instructional strategies that could improve students' critical thinking skills and engagement, recognizing the significance of critical thinking as a skill for the 21st century (Sung et al., 2019; Ramasamy & Razali, 2020). Inquiry-Based Learning (IBL) has arisen as a possible answer since it encourages active learning, problem-solving, and the enhancement of scientific inquiry skills. Implementing Inquiry-Based Learning (IBL) in the science classroom fosters critical thinking, challenges assumptions, requires data analysis, and promotes drawing conclusions based on evidence.

Utilizing IBL can enhance student engagement through promoting a learner-centered approach. IBL promotes student participation, interest, and motivation by engaging them in the learning process (Dimaunahan & Panoy, 2021). It offers chances for practical tasks, teamwork, and the investigation of real-life issues, which can greatly improve student involvement.

This research used a quantitative approach to study the effects of Inquiry-Based Learning (IBL) on student engagement and critical thinking skills by conducting pre-assessment and post-assessment measurements. The study attempted to analyze any notable disparities in students' critical thinking skills and levels of involvement by gathering data both before and after the adoption of IBL.

This study intended to enhance the current literature on successful teaching methods in scientific education by investigating these research questions. The results could offer significant guidance for educators, curriculum designers, and policymakers in creating and executing evidence-based methods that enhance critical thinking and student involvement. The project intended to enhance scientific education in the Philippines by highlighting the need of developing critical thinking skills and increasing student involvement through the use of Inquiry-Based Learning (IBL). Specifically, this hoped to answer the specific questions below.

1. What is the level of engagement of the respondents' before and after the use of IBL in terms of;
1.1 behavioral;
1.2 cognitive; and
1.3 emotional?
2. What are the pre-assessment and post-assessment mean level of the students' critical thinking skills in terms of?
2.1 analysis;
2.2 evaluation;
2.3 application;
2.4 inference; and
2.5 self-regulation?
3. Is there a significant difference in the scores of the respondents in the critical thinking skills before and after the utilization IBL?
4. Is there a significant difference in the level of engagement of the respondents before and after the utilization of IBL?

II. METHODOLOGY

Research Design. This research study utilized a pre-experimental single-group pretest-posttest design to investigate the effects of inquiry-based learning on the engagement and critical thinking skills of 10th-grade biology students at a specific school. The design was chosen based on various factors and the particular research questions being explored.

The study aimed to examine the efficacy of inquiry-based learning in enhancing students' engagement and critical thinking abilities. A pre-experimental design was used to analyze the changes in these variables before and after the intervention (IBL) was implemented. The approach allowed for comparing participants' engagement levels and critical thinking skills before and after using IBL through pre-assessment and post-assessment measurements. A single-group design was selected due to the study's emphasis on a particular group of grade 10 students. The researcher utilized the entire student body as one group due to the school's restricted number of students. The research focused on analyzing changes within a single group rather of comparing many groups or situations. This design proved appropriate for assessing the intervention's effects on participants over time and identifying any significant differences.

The pretest was used to gather baseline data on the participants' engagement levels and critical thinking skills before introducing Inquiry-Based Learning (IBL). This information was used as a reference to assess the success of the intervention. The posttest measurement allowed for evaluating any changes or enhancements that arise due to the intervention. The research questions focused on evaluating engagement levels and critical thinking skills, which were well-suited to the chosen design. The pre-experimental single-group pretest-posttest approach allowed for the examination of changes in variables within the same group of participants.

The methodology, albeit lacking a control group, was appropriate for investigating the effects of inquiry-based training on learner engagement and critical thinking skills in the specific context. The results of this study offered initial insights into the potential efficacy of Inquiry-Based Learning (IBL) as a teaching method and laid the groundwork for future research in the field of scientific education.

Research Instruments. This study utilized two types of data gathering equipment. The initial set consists of two fifty-item assessments created to evaluate students' critical thinking abilities in the domains of analysis, evaluation, application, and inference. The examinations functioned as both pre-assessment and post-assessment instruments, evaluating students' cognitive capacities on pertinent themes. The exams were used to collect quantitative data on the variations in students' critical thinking abilities before and after introducing inquiry-based training.

The second tool utilized in this investigation was a survey-type questionnaire created expressly for this research. This questionnaire assesses students' engagement levels before and after implementing inquiry-based learning (IBL). The purpose is to encompass the behavioral, cognitive, and emotional components of involvement. The questionnaire included self-report items prompting students to assess their own level of involvement in the learning process (Wang & Eccles, 2018).

Utilizing various instruments improved the thoroughness of data collection by obtaining both objective measurements of critical thinking skills and subjective assessments of participation. The pre-assessment and post-assessment exams yielded quantifiable data that may be evaluated to assess the magnitude of changes in critical thinking skills. The survey form provided students with the opportunity to share their personal views and experiences regarding their engagement during the study, adding a qualitative dimension to the research.

The equipment utilized in this research were self-made, designed exclusively for this investigation. Although customization and alignment with research aims were possible, it is essential to verify the validity and reliability of these instruments. Before being put into use, the instruments underwent thorough validity and reliability testing, including expert review, to verify their accuracy in measuring the intended constructs.

The researcher can comprehensively examine the changes in students' critical thinking skills and engagement levels arising from the deployment of IBL by using a mix of tests and a survey questionnaire. This method offers a comprehensive evaluation, enhancing the data analysis by allowing the researcher to cross-reference the results and make stronger conclusions regarding the effects of IBL on certain variables.

Data Gathering Procedure. The data collection process commenced by disseminating the pre-test and survey questions to all participants through Google Forms. The pre-test was conducted to evaluate the students' critical thinking abilities, and their scores were documented and organized for future analysis. The students were asked to complete a self-made survey questionnaire simultaneously to assess their degree of participation prior to the lecture.

The researcher implemented inquiry-based learning (IBL) in two specific lessons after conducting a pre-test and survey. 1) Hereditary: Inheritance and Variation, and 2) Living Things and Their Environment. The researcher utilized Inquiry-Based Learning (IBL) throughout these lessons. The inquiry allowed students to examine issues through practical experience, participate in discussions, and utilize critical thinking abilities.

The post-test was given after the IBL lessons to evaluate any improvements in the students' critical thinking abilities following the teaching. The post-test scores were recorded and tallied together with the pre-test scores. This enabled a comparison of the pupils' performance pre and post the introduction of IBL.

All the test scores were finally gathered and arranged for statistical analysis. The gathered data underwent suitable statistical analysis to assess the significance of any detected alterations in the students' critical thinking abilities. The second survey questionnaire results were collated and evaluated to evaluate the students' participation levels before and after the teaching.

Respondents of the Study. The participants in the study were tenth-grade students from a specific school in Lipa. Respondents were required to meet the selection criteria of being currently enrolled in grade 10, studying biology, and wanting to engage in the study. The exact number of respondents was not specified in the provided information. The study aims to include a sufficient number of participants to provide a representative sample and to offer valuable insights into the effects of inquiry-based learning (IBL) on students' critical thinking skills and engagement levels.

The study employed purposive sampling as the sample method. Purposive sampling is a non-probability

sampling technique where participants are chosen based on particular criteria that match the research goals. The researcher chose grade 10 pupils from a certain school who were enrolled in the study. The researcher employed purposive sampling to guarantee that the participants were pertinent to the research focus and have the required background knowledge to participate in the study.

Statistical Treatment of Data.The researcher utilized statistical means to compare the abilities of Grade 10 pupils in order to address the research challenge and derive insights from the acquired data. The researcher utilized T-tests, a statistical method for comparing the means of students' pre-test and post-test scores. Furthermore, standard deviation, frequency, percentage, and paired t-test were utilized to measure students' participation. Cronbach Alpha is a measure of internal consistency that offers dependability information for things scored dichotomously, like multiple-choice items (Tobian, 2019).

III. RESULTS AND DISCUSSION

Table 1. Level of Behavioral Engagement before and after Utilization of IBL

Indicators	Before		
	M	SD	VI
1. I pay attention in class.	2.48	.640	ME
2. I am motivated to learn about future lessons.	2.48	.554	ME
3. I am curious about answers to problems to gain deeper understanding the concepts taught.	2.68	.656	E
4. I find lessons interesting.	2.55	.749	E
5. I am now interested in learning things for school.	2.62	.586	E
Overall	2.56	.327	E
Indicators	After		
	M	SD	VI
1.	3.58	.501	HE
2.	3.43	.501	E
3.	3.40	.496	E
4.	3.60	.496	HE
5.	3.53	.506	HE
Overall	3.51	.323	HE

Legend: 1.0-1.49 (Not Engaged at All); 1.50-2.49 (Moderately Engaged); 2.50-3.49 (Engaged); 3.50-4.0 (Highly Engaged)

The table shows how participants' assessed engagement levels in terms of behavioral markers changed before and after receiving instruction. The signs include of attentiveness in class, eagerness to explore upcoming lessons, inquisitiveness about problem-solving for better comprehension, finding classes engaging, and heightened enthusiasm for academic learning. Before teaching, the composite mean for these markers was 2.56 (Engaged), which increased to 3.51 (Highly Engaged) following instruction.

The data indicates that the respondents' reported levels of engagement notably rose after receiving instruction, particularly in terms of behavioral indicators. The average scores for all indicators demonstrated progress, with the post-instruction values ranging from "Moderately Engaged" to "Engaged." IBL training had a favorable impact on the respondents' engagement levels, increasing their attentiveness, motivation, curiosity, and interest in the subject matter.

The results have significant consequences for teaching methods and approaches. The noticeable rise in perceived engagement levels following instruction indicates that the teaching strategies employed were successful in engaging students and encouraging their active participation in the learning process (Malanog & Aliazas, 2021). It emphasizes the significance of using captivating teaching methods including interactive exercises, real-world connections, and problem-solving opportunities to increase student engagement and facilitate a better grasp of the subjects being taught.

Various studies have emphasized the influence of active student involvement on educational achievements. Fredricks, Blumenfeld, and Paris (2018) highlighted that student engagement is crucial for academic success and favorable educational outcomes. Hidi and Renninger (2018) stated that curiosity and interest are important factors in enhancing engagement and facilitating a more profound comprehension.

The data shows that respondents' perceived levels of involvement improved after receiving instruction, indicating

the efficiency of the instructional approaches used. The results underscore the significance of integrating captivating tactics in instruction to boost student motivation, curiosity, and interest in the topic. Educators can use interactive activities, problem-solving challenges, and real-world connections to encourage active involvement and enhance students' knowledge, resulting in enhanced learning outcomes.

The statement "I pay attention in class" had the lowest mean of 2.48 among all statements in the pre-test data. On average, respondents believed that paying attention in class partially applied to them before the lecture.

The statement "I find lessons interesting" had the highest mean in the post-test data, with a mean of 3.60. On average, respondents strongly agreed that finding lessons more engaging was extremely true of them after the instruction.

The disparity in averages between the initial and final test scores indicates the influence of the IBL teaching on the participants' reported involvement levels. The rise in the average score for "I find lessons interesting" suggests that the teaching effectively boosted the participants' interest and involvement in the sessions. The lessons became more engaging due to the use of IBL instructional methodologies, which included including interactive exercises.

The lower average score in the pre-test for "I pay attention in class" indicates that respondents had the opportunity to enhance their attentiveness before the lesson. The post-test findings indicate a notable rise in the mean score from 2.48 to 2.48, demonstrating that the training had a beneficial impact on their attention in class. The focused learning environment was enhanced by IBL strategies such clear instructions, active student participation, and effective classroom management techniques (Jensen, 2018).

Table 2. Level of Cognitive Engagement before and after Utilization of IBL

Indicators	Before		
	M	SD	VI
6. I exert effort in working into difficult problems and concepts until I find solutions.	2.75	.588	E
7. I persist on challenging tasks.	2.53	.554	E
8. I demonstrate effort in accomplish task.	2.33	.656	ME
9. I take effort to solve examples and applications of the concepts taught to us in class.	2.68	.730	E
10. I create my own mapping of notes, ideas, and concepts I learn in Science.	2.50	.641	E
11. I justify concepts, principles, and processes by showing the reasoning behind them.	2.53	.877	E
12. I consider different ways in solving problems.	2.58	.781	E
13. I try to connect what I am learning with my own experiences.	2.20	.687	ME
14. I make up examples to help me understand the important concepts I learn from school.	2.18	.781	ME
Overall	2.47	.325	ME
Indicators	After		
	M	SD	VI
6.	3.60	.496	HE
7.	3.25	.543	E
8.	3.43	.549	E
9.	3.40	.496	E
10.	3.25	.439	E

11.	3.53	.506	HE
12.	3.50	.555	HE
13.	3.43	.501	E
14.	3.48	.506	E
Overall	3.43	.314	E

Legend: 1.0-1.49 (Not Engaged at All); 1.50-2.49 (Moderately Engaged); 2.50-3.49 (Engaged); 3.50-4.0 (Highly Engaged)

The table displays the participants' perceived cognitive engagement levels before and after receiving instruction. The signs consist of exerting effort, tenacity, task achievement, problem-solving, idea mapping, justification of concepts, linkage with personal experiences, and providing instances. The composite mean scores for the pre-test and post-test, along with their standard deviations (SD) and the respective level of engagement, are presented.

The pre-test results show a composite mean score of 2.47, suggesting that respondents generally evaluated their participation in cognitive components as moderately engaging before the teaching. After the instruction, the composite mean score in the post-test increased to 3.43, indicating a considerable improvement in their level of involvement, which was evaluated as engaging.

The rise in the composite mean score indicates that the IBL teaching positively influenced the cognitive engagement of the participants. The particular signs show enhancements in different areas, including higher dedication to solving complex problems, persistence in tough activities, greater effort in completing tasks, and the ability to relate concepts to personal experiences (Lane et al., 2018). The enhancements are in line with the goal of promoting critical thinking, problem-solving abilities, and a more profound comprehension. Studies confirm that Inquiry-Based Learning (IBL) instructional methods can improve cognitive engagement and critical thinking abilities. Hmelo-Silver et al. (2018) suggest that problem-based learning, which involves active problem-solving and reflection, enhances students' cognitive engagement and fosters a profound knowledge of topics.

The study by Fredricks, Blumenfeld, and Paris (2018) highlights the significance of cognitive engagement in successful learning. Student involvement was discovered to encompass active effort, persistence, and the utilization of higher-order thinking skills, all of which are consistent with the markers in the current study (Custodio et al., 2020).

The data shows that the IBL teaching had a beneficial impact on the respondents' cognitive involvement. The composite mean score considerably increased from somewhat true engagement to fully true engagement after the teaching. The results indicate that Inquiry-Based Learning (IBL) training improved several cognitive qualities such as effort, persistence, problem-solving, concept mapping, justification, and relating to personal experiences. The enhancements are in line with studies on teaching methods that enhance cognitive engagement and critical thinking skills. They underscore the significance of active learning techniques in developing profound comprehension and the application of knowledge in students (Laya & Ramos, 2020).

The statement "I easily try to connect what I am learning with my own experiences" had the lowest mean score in the pre-test, with a mean of 2.20. This suggests that, on average, respondents viewed this aspect of cognitive engagement as moderately engaged before the IBL instruction. It implies that they had difficulty connecting their learning to their personal experiences.

The statement "I exert more effort in working into difficult problems and concepts until I find solutions" had the highest mean score in the pre-test, with a mean of 2.75, indicating active involvement. On average, respondents said they were exerting a modest amount of effort in addressing difficult topics and concepts. It implies that they were more actively involved in making an effort to solve challenges.

The statement "I create my own mapping of notes, ideas, and concepts I learn in Science" received the lowest mean score of 3.25 in the post-test findings. On average, respondents believed they were fairly involved in making their own mappings of taught knowledge. It indicates that they made some advancements but may still have areas where they can enhance their cognitive involvement.

The statement "I exert effort in working into difficult problems and concepts until I find solutions" had the highest mean score in the post-test, with a mean of 3.60. On average, respondents said they exerted more effort in addressing difficult problems and concepts after the IBL session. The training appears to have positively influenced their motivation and determination to overcome challenges.

In conclusion, the findings suggest that the IBL course positively impacted the respondents' cognitive involvement. It resulted in a higher perceived level of effort and persistence while tackling challenging tasks and concepts. Further improvement is required in establishing personal mappings of learnt knowledge and integrating learning with personal experiences.

The results are consistent with studies on the efficacy of Inquiry-Based Learning (IBL) in encouraging active learning and cognitive engagement. Research has demonstrated that Inquiry-Based Learning (IBL) methods improve problem-solving skills, critical thinking capabilities, and student motivation (Savin-Baden & Major, 2018; Walker & Leary, 2018).

The IBL training had a favorable impact on the respondents' cognitive engagement, as seen by the higher mean scores in different indicators. The findings emphasize the significance of utilizing teaching methods that promote challenging problem-solving and offer chances for personal connections to improve students' cognitive involvement and educational achievements.

Table 3. Level of Emotional Engagement before and after Utilization of IBL

Indicators	Before		
	M	SD	VI
15. I ask questions to my teacher in class.	2.45	.639	ME
16. I am eager to hear how my classmates evaluate my work.	2.25	.670	ME
17. I am eager to hear teachers' feedback of my work.	2.40	.672	ME
18. I am eager to see my grades.	2.15	.700	
19. I am taking advantage of opportunities to showcase what I learned.	2.08	.526	ME
20. I take initiatives to evaluate my own work and reflect on my scores.	2.13	.563	ME
Overall	2.24	.468	ME
Indicators	After		
	M	SD	VI
15.	3.47	.506	E
16.	3.53	.506	HE
17.	3.43	.549	E
18.	3.42	.501	E
19.	3.43	.501	E
20.	3.55	.504	HE
Overall	3.47	.300	E

Legend: 1.0-1.49 (Not Engaged at All); 1.50-2.49 (Moderately Engaged); 2.50-3.49 (Engaged); 3.50-4.0 (Highly Engaged)

Table 3 displays the perceived level of emotional engagement before and after teaching-Based Learning (IBL) teaching. The signs consist of inquiring, enthusiasm for assessment and feedback, concern for grades, utilizing opportunities to demonstrate learning, and self-assessment. The average emotional engagement indicators rose from 2.24 (Moderately Engaged) to 3.47 (Engaged) after IBL instruction.

The rise in the composite mean indicates that IBL education positively influenced students' emotional engagement. Before the training, students reported a moderate level of emotional engagement, but following the lesson, their impression changed to a high level of emotional engagement. Students showed increased emotional engagement and investment in their learning experiences.

The results are consistent with prior studies emphasizing the significance of emotional involvement in enhancing successful learning results. Emotional involvement plays a crucial role in academic success and favorable educational encounters, as stated by Fredricks, Blumenfeld, and Paris (2018). Heightened emotional involvement can result in increased motivation, passion, and introspection, ultimately improving learning results (Delen & Gulbahar, 2019; Wang et al., 2019).

The transition from a partially authentic level to an authentic level of emotional involvement indicates that IBL education established a nurturing and captivating learning atmosphere. This teaching method probably encouraged students to be curious, interested, and reflective, resulting in higher emotional involvement.

The research confirms that IBL instruction is beneficial in enhancing emotional engagement in pupils. The results suggest that students showed increased enthusiasm in asking questions, receiving assessment and feedback, and taking the lead in evaluating their own work (Cooper & Robinson, 2019). IBL instruction fostered a good emotional environment, motivating students to engage actively,

contemplate their learning, and pursue chances for development.

By integrating Inquiry-Based Learning (IBL) tactics into instructional methods, educators can foster emotional involvement, leading to improved learning results. This is consistent with the literature that highlights the significance of emotional involvement in enhancing academic success and fostering enjoyable educational experiences (Mendoza & Hernandez, 2018). It emphasizes the need of establishing supportive and engaging learning settings that foster students' emotional engagement in their educational experience (Fredricks, Blumenfeld, & Paris, 2018; Hidi & Renninger, 2018).

These examples demonstrate the beneficial effect of IBL education on emotional engagement and stress the importance of educators taking emotional factors into account when creating instructional methods to promote interactive and significant learning experiences.

Table 4. Mean Level of Students' Critical Thinking Skills

Critical Thinking Skills	Before		
	M	SD	VI
Analysis	67.90	3.68	B
Evaluation	68.82	4.33	B
Application	69.83	4.09	B
Inference	66.42	3.67	B
Self-Regulation	66.17	3.55	B
Overall	67.83	2.16	B
Critical Thinking Skills	After		
	M	SD	VI
Analysis	83.75	15.88	AP
Evaluation	78.52	11.12	D
Application	73.75	6.85	B
Inference	83.47	8.92	AP
Self-Regulation	81.25	11.00	AP
Overall	80.15	7.73	AP

Legend: 1.0-1.49 (Not Engaged at All); 1.50-2.49 (Moderately Engaged); 2.50-3.49 (Engaged); 3.50-4.0 (Highly Engaged)

The table displays the total scores before and after Instruction-Based Learning (IBL). The total score reflects the proficiency of critical thinking skills in analysis, evaluation, application, inference, and self-regulation. Student competency levels increased from the Beginning level, with an average score of 67.83 before IBL teaching, to the Approaching Proficiency level, with an average score of 80.15 after IBL instruction.

The increase in the total scores indicates that Inquiry-Based Learning (IBL) positively influenced students' critical thinking abilities. Prior to the guidance, students' results were categorized in the Beginning range, signifying that they were advancing but had not yet achieved competency. Following the guidance, their scores transitioned to the Approaching competency level, suggesting they were progressing towards obtaining competency in critical thinking.

The results are consistent with prior studies highlighting the efficacy of Inquiry-Based Learning methods in improving critical thinking abilities. Research indicates that Inquiry-Based Learning (IBL) education encourages active learning, problem-solving, and higher-order thinking, all crucial aspects of critical thinking (Savin-Baden & Major, 2018; Walker & Leary, 2019).

The enhancement of critical thinking skills indicates that Inquiry-Based Learning (IBL) helped students increase their abilities in analysis, evaluation, application, inference, and self-regulation (Reyes & Balagtas, 2020). IBL tactics probably promoted pupils to engage in critical thinking, analyze data, assess arguments, apply knowledge to practical scenarios, draw conclusions, and manage their cognitive processes.

The evidence confirms that Inquiry-Based Learning (IBL) is beneficial in enhancing students' critical thinking skills. The transition from Developing to Approaching Proficiency in the overall scores suggests that students improved in their capacity to analyze, evaluate, apply, infer, and self-regulate (Salvaña et al., 2018). IBL instruction facilitated students' engagement in higher-order thinking and the cultivation of critical thinking skills.

Educators can cultivate critical thinking abilities by incorporating IBL tactics into their education. This aligns with research emphasizing the importance of active learning and problem-solving in fostering critical thinking (Savin-Baden & Major, 2020; Walker & Leary, 2019). The results emphasize the significance of integrating teaching methods that promote critical thinking, involve students in solving complicated problems, and allow them to apply their knowledge in practical ways.

The results shows that Inquiry-Based Learning (IBL) has a favorable impact on students' critical thinking skills in many areas. The enhancement in analysis, inference, and self-regulation is especially remarkable, as these abilities signify advanced levels of critical thinking. Yet, there is potential for advancement in evaluation and application abilities, as pupils' scores have consistently fallen within the Developing or Beginning categories.

The results shows that IBL has a positive impact on students' critical thinking skills. The increase in the total scores suggests advancement towards achieving competency in critical thinking. Educators should keep using Inquiry-Based Learning methodologies to promote critical thinking skills in different situations.The IBL probably offered students chances for active participation, problem-solving, and higher-level thinking. These results are consistent with earlier research showing that Inquiry-Based Learning (IBL) is beneficial in enhancing critical thinking skills (Savin-Baden & Major, 2018; Walker & Leary, 2019). IBL encourages students to understand intricate situations, draw logical conclusions, and critically assess material, leading to enhanced critical thinking skills.The significant enhancement in analysis skills is in line with the research that highlights the importance of fostering analytical thinking in educational environments. Halpern (2018) defines analytical thinking as the capacity to deconstruct intricate situations, recognize patterns, and assess evidence (Fideli & Aliazas, 2022). The IBL approach, focusing on active problem-solving and analysis, probably helped students improve their analytical skills through support and practice.The notable enhancement in inference skills indicates that the IBL teaching helped students derive logical conclusions from the material at hand. Hmelo-Silver et al. (2018) found that problem-based learning, a part of inquiry-based learning, can improve students' inference skills by offering genuine problem-solving experiences and chances to analyze difficult circumstances.

The enhancement in self-regulation abilities following Inquiry-Based Learning (IBL) is remarkable, given that self-regulation is frequently viewed as a more difficult component of critical thinking. Self-regulation entails overseeing cognitive processes, establishing objectives, and efficiently controlling one's learning. IBL has a beneficial effect on self-regulation, which is consistent with Zimmerman and Schunk's (2018) research highlighting that self-regulated learning can be improved by teaching methods that encourage active participation, metacognitive processes, and goal-setting. The IBL probably offered students the framework and assistance needed to cultivate and enhance their self-regulation abilities (Christenson et al., 2019).

Although the results for evaluation and application did not demonstrate substantial gains in comparison to other categories, it is crucial to acknowledge that these abilities may need additional development in the future. Enhancement in these areas could be influenced by factors like task complexity, instructional scaffolding, and consistent practice and feedback. Additional research and instructional improvements may be necessary to improve students' ability to evaluate and apply knowledge in the setting of Inquiry-Based Learning (IBL).

IBL can positively influence students' critical thinking skills, leading to significant enhancements in analysis, inference, and self-regulation. The results align with the current research on inquiry-based learning (IBL) and its capacity to encourage active participation, problem-solving, and advanced cognitive skills. The IBL probably offered students the essential assistance and chances to enhance their critical thinking skills, allowing them to excel in analysis, inference, and self-regulation. Consistent use of Inquiry-Based Learning (IBL) and specific methods to improve assessment and application abilities can result in improved critical thinking results in students.

Table 5. Significant difference in the scores of the respondents in the critical thinking skills before and after the utilization of IBL

Critical Thinking Skills	Mean	t	df	Sig.
Analysis	15.850	6.142	39	.000
Evaluation	9.700	5.128	39	.000
Application	3.925	3.394	39	.002
Inference	17.050	11.208	39	.000
Self-Regulation	15.075	8.784	39	.000
Overall	12.32000	10.528	39	.000

Table 5 demonstrates a notable disparity in the respondents' critical thinking levels before and after implementing IBL. The table displays the notable variations in the average scores of critical thinking before and after the implementation of IBL (Inquiry-Based Learning). The findings show notable enhancements in all aspects of critical thinking, such as Analysis, Evaluation, Application, Inference, Self-regulation, and overall scores following the IBL course.

This study's results align with prior research indicating that Inquiry-Based Learning (IBL) can improve critical thinking abilities (Niu, Guo, & Li, 2020; Lin & Lien, 2021). Lin and Lien (2021) suggest that Inquiry-Based Learning (IBL) enhances students' critical thinking skills through activities that involve obtaining and analyzing information, assessing evidence, generating inferences, and reflecting on their thinking processes.

The results suggest that Inquiry-Based Learning (IBL) can effectively enhance students' critical thinking skills (Lin & Lien, 2021). Educators and institutions should include Inquiry-Based Learning (IBL) in their teaching methods to improve students' critical thinking skills (Malicdem & Perez, 2018). Moreover, these results indicate that educators should

offer students chances to participate in inquiry-based tasks that encourage active learning and critical thinking.

The study's findings indicate that Inquiry-Based Learning (IBL) can greatly improve students' critical thinking abilities. The results have significant implications for educators and institutions, endorsing the use of Inquiry-Based Learning (IBL) as an effective approach for fostering critical thinking skills.

Table 6. Significant difference in the level of students' engagement before and after the utilization of IBL

Critical Thinking Skills	Mean	t	Sig.	Remarks
Behavioral	.94500	12.415	.000	Significant
Cognitive	.95556	13.494	.000	Significant
Emotional	1.22917	13.834	.000	Significant

There is a notable disparity in the level of learners' involvement of the participants before and after the implementation of Inquiry-Based Learning (IBL). The table displays the notable variations in behavioral, cognitive, and emotional engagement of learners before and after implementing Inquiry-Based Learning (IBL) in the context of critical thinking. The mean differences were determined to be statistically significant with p-values of .000. The table data shows that using IBL in the educational strategy resulted in notable enhancements in behavioral, cognitive, and emotional engagement among the participants.

The notable variations in the average scores indicate that the use of IBL techniques had a good impact on learners' involvement in behavioral, cognitive, and emotional elements. The results suggest that the teaching method successfully increased the students' engagement, analytical thinking, and emotional investment in the educational experience.

The findings have significance for educators and instructional designers in advancing efficient teaching and learning methods. Educators can enhance student engagement by integrating Inquiry-Based Learning (IBL) methodologies into their teaching methods. This can enhance critical thinking abilities and enrich the learning process.

The results are consistent with existing research on the significance of learner engagement in promoting successful learning results. Studies indicate that learner engagement correlates with heightened motivation, active participation, and a more profound comprehension of the subject matter (Fredricks, Blumenfeld, & Paris, 2018; Kahu, 2021). IBL strategies engage students in the learning process, encourage critical thinking, and foster a stronger relationship with the topic.

The results in the table shows that using IBL led to substantial enhancements in learners' engagement in behavioral, cognitive, and emotional elements. The results confirm that these teaching methods are successful in encouraging students to actively participate, think critically, and become emotionally engaged. Educators can utilize these tactics to establish a more captivating and richer learning atmosphere, resulting in higher learning results and enhanced critical thinking abilities.

IV. CONCLUSIONS

This research section offers a thorough summary of the main discoveries from a study that investigated the effects of Inquiry-Based Learning (IBL) on students' engagement and critical thinking abilities.

There are notable variations in the scores of the participants in the critical thinking abilities of students before and after the implementation of Inquiry-Based Learning (IBL). Reject H01. However, there are notable disparities in the extent of learners' involvement when comparing before and after the implementation of Inquiry-Based Learning (IBL).

Inquiry-Based Learning (IBL) enhances student engagement. The participants indicated heightened behavioral involvement, such as attentiveness, motivation, curiosity, and interest in learning. Cognitive engagement was also enhanced, leading to improvements in effort, tenacity, problem-solving skills, and deeper understanding. Students exhibited heightened emotional involvement, demonstrating higher enthusiasm for assessment, self-assessment, and commitment to their learning experiences.

Instruction-Based Learning has a positive impact on students' critical thinking abilities. Both the initial assessment and final assessment scores show substantial enhancements in every aspect of critical thinking, such as analysis, evaluation, application, inference, and self-regulation. These enhancements indicate that Inquiry-Based Learning (IBL) methods promoted critical thinking skills, including interpreting information, evaluating arguments, applying knowledge, making inferences, and regulating cognitive processes.

Implementing Inquiry-Based Learning strategies led to substantial enhancements in learners' involvement. Statistically substantial increases were observed in the mean

scores for behavioral, cognitive, and emotional involvement following the implementation of these techniques. IBL techniques significantly improved students' engagement, critical thinking, and emotional investment in the learning process.

IBL has a beneficial effect on critical thinking skills and learner engagement, indicating that this teaching method can enhance students' academic and personal growth. By nurturing critical thinking skills and involvement, kids are more prepared to address intricate issues, think autonomously, and engage actively in their educational path.

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