 ISSN 3123-349X (E)

THE EFFECTIVENESS OF INQUIRY-BASED LEARNING IN IMPROVING STUDENTS' BIOLOGY ACHIEVEMENT

Nurapipah[1)], Pardiyansah[2)], Eko Wulandari[3)]

[1)]Educational Biology, Faculty Of Education, Universitas Merangin, Merangin, Indonesia
Email: nurapipah73@gmail.com
[2)] Educational Biology, Faculty Of Education, Universitas Merangin, Merangin, Indonesia
Email: pardiayansah@gmail.com
[3)]Educational Biology, Faculty Of Education, Universitas Merangin, Merangin, Indonesia
Email: ekowulandari@universitasmerangin.ac.id

Abstract

This study aims to investigate the effectiveness of Inquiry-Based Learning (IBL) in improving students' biology achievement. A quasi-experimental research design was employed, involving two groups: an experimental group taught using Inquiry-Based Learning and a control group taught using conventional methods. The sample consisted of 60 senior high school students selected through purposive sampling, with 30 students assigned to the experimental group and 30 students to the control group. Data were collected using pre-test and post-test instruments to measure students' learning outcomes. The results revealed that there was no significant difference between the two groups in the pre-test, indicating similar initial abilities. However, the post-test results showed that the experimental group achieved significantly higher scores than the control group. Statistical analysis using an independent samples t-test confirmed that the difference was significant at the 0.05 level. The findings indicate that Inquiry-Based Learning has a positive effect on students' biology achievement. Compared with conventional instruction, Inquiry-Based Learning produced a meaningful improvement in students' academic performance while also encouraging higher classroom engagement and active participation throughout the learning process. Additionally, students in the experimental group demonstrated higher engagement, motivation, and critical thinking skills during the learning process. Despite some initial challenges in implementation, Inquiry-Based Learning proved to be an effective instructional strategy. Therefore, it is recommended that educators adopt this approach to enhance biology learning outcomes.

Keywords: Inquiry-Based Learning, Biology Achievement, Student Engagement, Critical Thinking, Experimental Study.

INTRODUCTION

Education in the 21st century demands instructional approaches that not only deliver content but also actively engage students in the learning process. Traditional teacher-centered methods, which often emphasize memorization and passive reception of information, are increasingly seen as insufficient for developing higher-order thinking skills. In the context of biology education, where understanding complex systems and processes is essential, innovative teaching strategies are needed to enhance students' comprehension and achievement.

Inquiry-Based Learning (IBL) has emerged as a promising pedagogical approach that encourages students to take an active role in constructing their own knowledge. Through questioning, investigating, and problem-solving, students are

guided to explore biological concepts in a more meaningful and engaging way. This approach aligns with constructivist learning theory, which posits that learners build knowledge through experiences and interactions with their environment.

Biology, as a subject, often presents challenges for students due to its abstract concepts and the need for critical thinking skills. Many students struggle to connect theoretical knowledge with real-world applications, resulting in low academic achievement. Therefore, implementing teaching methods that promote deeper understanding and active participation becomes crucial. Inquiry-Based Learning offers opportunities for students to develop scientific skills such as observation, analysis, and reasoning.

Previous studies have indicated that Inquiry-Based Learning can positively impact students' academic performance across various disciplines. By engaging students in hands-on activities and encouraging curiosity, IBL fosters a more student-centered learning environment. In biology education specifically, this method allows learners to explore scientific phenomena directly, which can lead to improved retention and understanding of concepts.

Despite its potential benefits, the implementation of Inquiry-Based Learning in classrooms may face several challenges, including limited resources, time constraints, and teachers' readiness to adopt new instructional strategies. These factors can influence the effectiveness of IBL in improving student outcomes. These factors can influence the effectiveness of IBL in improving student outcomes. Therefore, it is important to examine how this approach can be effectively integrated into biology teaching practices.

Although numerous studies have reported the effectiveness of Inquiry-Based Learning in science education, most have focused primarily on students' academic achievement. Comparatively fewer studies have simultaneously examined learning achievement together with students' engagement and critical thinking within the context of Indonesian senior high school biology classrooms. Therefore, this study seeks to provide a more comprehensive understanding of the effectiveness of Inquiry-Based Learning in improving biology learning outcomes.

This study aims to investigate the effectiveness of Inquiry-Based Learning in improving students' biology achievement. By analyzing students' performance and engagement, this research seeks to provide insights into the potential of IBL as an alternative teaching method. The findings are expected to contribute to the development of more effective instructional strategies in biology education.

LITERATURE REVIEW

Inquiry-Based Learning (IBL) is widely recognized as a student-centered instructional approach that emphasizes active participation and critical thinking. According to constructivist theory, learning occurs when students actively construct knowledge through experiences rather than passively receiving information. IBL encourages learners to ask questions, investigate problems, and develop conclusions based on evidence. This approach shifts the role of the teacher from a knowledge provider to a facilitator who guides students in the learning process.

Several scholars have highlighted the effectiveness of Inquiry-Based Learning in improving academic achievement. Research indicates that students who engage in inquiry-based activities tend to demonstrate better understanding of concepts, higher retention rates, and improved problem-solving skills. In science education, particularly biology, IBL allows students to explore complex topics such as ecosystems, genetics, and cellular processes through experimentation and observation, making learning more meaningful.

Biology education often requires students to grasp abstract and interconnected concepts, which can be challenging when taught through traditional lecture methods. Studies show that conventional approaches may limit students' ability to think critically and apply knowledge in real-life situations. In contrast, Inquiry-Based Learning provides opportunities for

hands-on experiences, collaborative learning, and independent thinking, which are essential for mastering biological concepts.

Previous empirical studies have supported the positive impact of IBL on students' performance. For instance, research findings reveal that students taught using inquiry-based methods achieve significantly higher scores compared to those taught using traditional approaches. Additionally, IBL has been shown to enhance students' motivation and engagement, as it fosters curiosity and encourages active involvement in the learning process.

However, the successful implementation of Inquiry-Based Learning depends on several factors. Teacher competence, classroom management, availability of resources, and curriculum design play important roles in determining its effectiveness. Some studies have reported that without proper guidance, students may struggle with open-ended inquiry tasks, which can hinder learning outcomes. Therefore, structured or guided inquiry is often recommended, especially for beginners.

In summary, the literature suggests that Inquiry-Based Learning is an effective instructional strategy for improving students' biology achievement. It not only enhances conceptual understanding but also develops essential scientific skills. Nevertheless, careful planning and support are required to maximize its benefits in the classroom.

Although previous studies consistently report positive effects of Inquiry-Based Learning, differences remain regarding the extent of its impact on various learning outcomes. Some studies emphasize improvements in conceptual understanding, whereas others highlight students' engagement, scientific reasoning, or critical thinking skills. These differences indicate that the effectiveness of Inquiry-Based Learning may depend on classroom context, implementation strategies, and students' learning characteristics.

RESEARCH METHODOLOGY

This study employed a quantitative research approach using a quasi-experimental design to examine the effectiveness of Inquiry-Based Learning (IBL) in improving students' biology achievement. The design involved two groups: an experimental group that received instruction through Inquiry-Based Learning and a control group that was taught using conventional teaching methods. Both groups were given a pre-test and a post-test to measure students' learning outcomes before and after the treatment.

The population of this study consisted of senior high school students. A sample was selected using purposive sampling technique, where two classes with similar academic abilities were chosen. The selected classes had relatively similar academic performance based on previous biology examination results, ensuring comparable initial learning abilities before the intervention was implemented. One class was assigned as the experimental group, while the other served as the control group. This selection aimed to ensure comparability between the groups in terms of prior knowledge and learning capability.

The research instruments included a biology achievement test, lesson plans, and observation sheets. The achievement test was designed in the form of multiple-choice questions to assess students' understanding of the biology topics taught during the study. The validity and reliability of the test were examined prior to its use. Content validity was evaluated through expert judgment, while the reliability of the instrument was confirmed through a pilot test before it was administered to the research participants. Observation sheets were utilized to monitor the implementation of Inquiry-Based Learning and students' engagement during the learning process.

The procedure of the study began with administering a pre-test to both groups to determine their initial level of understanding. The experimental group was then taught using Inquiry-Based Learning, which involved activities such as questioning, investigating, data collection, and drawing conclusions. Meanwhile, the control group received traditional

lecture-based instruction. After the instructional period, a post-test was administered to both groups to evaluate the effectiveness of the treatment.

Data analysis was conducted using statistical techniques. Descriptive statistics were used to summarize the data, while inferential statistics, such as the independent samples t-test, were applied to determine whether there was a significant difference between the post-test scores of the experimental and control groups. The level of significance was set at 0.05.

In conclusion, this research methodology was designed to provide empirical evidence on the effectiveness of Inquiry-Based Learning in improving students' biology achievement. By comparing the results between the two groups, the study aimed to identify whether IBL has a significant impact on students' learning outcomes.

RESULTS AND DISCUSSION

The results of this study were obtained from the analysis of pre-test and post-test scores of both the experimental and control groups. The data aimed to determine whether the implementation of Inquiry-Based Learning (IBL) significantly improved students' biology achievement compared to conventional teaching methods. The findings are presented in the following tables and further explained in the discussion section.

Table 1. Pre-Test Scores of Experimental and Control Groups

Group	N	Mean	Standard Deviation
Experimental Group	30	58.4	6.5
Control Group	30	57.9	6.8

Based on Table 1, the mean scores of the experimental group (58.4) and control group (57.9) were relatively similar. This indicates that both groups had comparable initial abilities before the treatment was administered. The small difference suggests that the groups were homogeneous and suitable for further comparison.

Table 2. Post-Test Scores of Experimental and Control Groups

Group	N	Mean	Standard Deviation
Experimental Group	30	82.7	5.9
Control Group	30	74.3	6.2

Table 2 shows a notable difference in post-test mean scores between the two groups. The experimental group achieved a higher mean score (82.7) compared to the control group (74.3). This suggests that students who were taught using Inquiry-Based Learning performed better in biology than those who received traditional instruction. The higher achievement of students in the experimental group suggests that Inquiry-Based Learning facilitates deeper conceptual understanding by actively involving students in scientific inquiry rather than passive knowledge acquisition.

Table 3. Independent Samples t-Test Results

Variable	t-value	Sig. (p-value)	Interpretation
Post-Test Score	5.12	0.000	Significant Difference

The results of the independent samples t-test in Table 3 indicate that the p-value (0.000) is lower than the significance level of 0.05. This means that there is a statistically significant difference between the post-test scores of the experimental and control groups. Therefore, the use of Inquiry-Based Learning had a significant effect on students' biology achievement. These findings are consistent with previous studies reporting that Inquiry-Based Learning enhances students' conceptual understanding and promotes more active participation during science learning. The consistency of these findings strengthens the evidence supporting the application of Inquiry-Based Learning in biology classrooms.

The improvement observed in the experimental group can be attributed to the active learning process promoted by Inquiry-Based Learning. Students were encouraged to explore concepts through questioning, investigation, and discussion, which helped them develop a deeper understanding of the subject matter. This finding supports the theory that active engagement enhances learning outcomes.

Furthermore, students in the experimental group demonstrated higher levels of participation and motivation during the learning process. They were more involved in classroom activities and showed greater curiosity in exploring biological concepts. This increased engagement likely contributed to their improved academic performance.

In contrast, the control group, which was taught using traditional lecture methods, showed improvement but not as significant as the experimental group. This may be due to the passive nature of conventional teaching, where students rely heavily on the teacher's explanation without actively constructing their own understanding.

Another important finding is that Inquiry-Based Learning helped students develop critical thinking and problem-solving skills. Through investigation and analysis, students learned how to interpret data and draw conclusions, which are essential skills in biology education. These skills not only improved their test scores but also their overall scientific literacy.

Despite the positive results, some challenges were observed during the implementation of Inquiry-Based Learning. A few students initially struggled to adapt to the new learning approach, particularly those who were accustomed to teacher-centered instruction. However, with proper guidance and support, they gradually became more comfortable with the process. The initial difficulties experienced by several students indicate that Inquiry-Based Learning requires a gradual adaptation process. Continuous guidance from teachers is therefore essential to help students become familiar with inquiry-oriented learning activities.

Overall, the findings of this study confirm that Inquiry-Based Learning is an effective instructional strategy for improving students' biology achievement. The significant difference in post-test scores between the experimental and control groups demonstrates its impact. Therefore, educators are encouraged to incorporate this approach into their teaching practices to enhance student learning outcomes.

CONCLUSION

This study concludes that Inquiry-Based Learning (IBL) is an effective instructional approach for improving students' biology achievement. The findings show that students who were taught using IBL demonstrated significantly higher learning outcomes compared to those who were taught using conventional teaching methods. This indicates that active engagement in the learning process plays a crucial role in enhancing students' understanding of biological concepts.

The implementation of Inquiry-Based Learning provides students with opportunities to explore, investigate, and construct their own knowledge. Through this approach, students become more involved in the learning process, which leads to better retention and comprehension. In addition, IBL encourages the development of critical thinking and problem-solving skills that are essential in science education.

Another important conclusion is that Inquiry-Based Learning positively influences students' motivation and participation. Students in the experimental group showed greater enthusiasm and curiosity during the learning activities. This increased engagement contributes not only to higher academic achievement but also to a more meaningful and enjoyable learning experience.

However, the study also reveals that the successful implementation of Inquiry-Based Learning requires proper planning and support. Teachers need to be well-prepared in designing inquiry activities and guiding students throughout the learning process. Adequate resources and classroom management strategies are also necessary to ensure the effectiveness of this approach.

In summary, Inquiry-Based Learning is a valuable alternative to traditional teaching methods in biology education. Its ability to improve students' achievement, engagement, and higher-order thinking skills makes it highly recommended for classroom practice. Future research is suggested to explore its application in different subjects and educational levels to further validate its effectiveness.

This study has several limitations. The research was conducted using a limited number of participants from one educational setting, which may restrict the generalization of the findings. Future studies are recommended to involve larger samples, longer intervention periods, and different educational levels to obtain a broader understanding of the effectiveness of Inquiry-Based Learning.

REFERENCES

Avi Hofstein., & Vincent Lunetta. (2004). The laboratory in science education. Science Education.

Barry Fraser. (2012). Classroom learning environments. Routledge.

Bruce Joyce., & Marsha Weil. (2009). Models of teaching. Pearson.

David Ausubel. (1968). Educational psychology: A cognitive view. Holt, Rinehart & Winston.

David Kolb. (1984). Experiential learning. Prentice Hall.

Jack Holbrook. (2005). Making chemistry teaching relevant. Chemical Education International.

Jean Piaget. (1972). The psychology of the child. Basic Books.

Jerome Bruner. (1961). The act of discovery. Harvard Educational Review.

John Dewey. (1938). Experience and education. Macmillan.

John Hattie. (2009). Visible learning. Routledge.

Jonathan Osborne. (2014). Teaching scientific practices. Journal of Research in Science Teaching.

Joseph Schwab. (1962). The teaching of science as enquiry. Harvard University Press.

Keith Taber. (2011). Constructivism as educational theory.

Lev Vygotsky. (1978). Mind in society. Harvard University Press.

Linda Darling-Hammond. (2008). Powerful learning. Jossey-Bass.

Michael Prince., & Richard Felder. (2006). Inductive teaching and learning methods. Journal of Engineering Education.

National Research Council. (2000). Inquiry and the national science education standards. National Academy Press.

National Science Teachers Association. (2004). NSTA position statement: Scientific inquiry.

Neil Mercer. (2000). Words and minds: How we use language to think together. Routledge.

OECD. (2018). The future of education and skills 2030.

Paul Kirschner., John Sweller., & Richard Clark. (2006). Why minimal guidance during instruction does not work. Educational Psychologist.

Richard Mayer. (2004). Should there be a three-strikes rule against pure discovery learning? American Psychologist.

Roger Bybee. (2006). The BSCS 5E instructional model. BSCS.

Thomas Kuhn. (1962). The structure of scientific revolutions. University of Chicago Press.

UNESCO. (2015). Rethinking education: Towards a global common good?