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The Influence of Inquiry Learning Model on Grade X Students Biology Learning Outcomes in Ecosystem Material

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ABSTRACT

The present study aims to: 1) interpret the influence of the inquiry learning model on students' biology learning outcomes; 2) interpret the implementation of each stage of the inquiry learning model. The present study is quantitative research using a quasi-experimental design, which was carried out at SMA Negeri 2 South Konawe. The research samples were grade X MIPA1 students as the experimental class and grade X MIPA3 students as the control class. The data collection technique for this research is tests that were analyzed descriptively and inferentially, as well as observations to interpret the implementation of the inquiry learning model. The results show that: 1) the inquiry learning model has a positive effect on the biology learning outcomes of grade X students on the ecosystem material. The inquiry learning model has an effective effect of 74.82% in learning activities and 25.18% is influenced by other variables which are not examined in this research, so the model is categorized as quite effective; 2) the inquiry learning model applied to grade X ecosystem material has difficulties in learning activities, namely difficulties in orienting the material and formulating problems. The biggest difficulty faced by the teacher is collecting data and drawing conclusions, which is caused by the teacher's lack of ability to organize the learning time.
Keywords: Inquiry; Learning outcomes Biology; Ecosystem

INTRODUCTION

The current industrial revolution 4.0 sees that education plays a vital role in preparing the young generation to face future challenges. The world of education implements a system in which the learning process not only focuses on mastering content but also on developing 21st-century skills (Schwab, 2019). Therefore, in rapid technological change and development, conventional teacher-centered learning models are often considered inadequate to meet modern learning needs. It applies to all materials/subjects, especially to subjects that study and analyze natural phenomena, such as chemistry, physics, and biology.

Biology subjects study broad and varied study objects, such as various kinds of living creatures, from microorganisms, plants, and animals to humans, which cover different levels of living organization, from cells to ecosystems and the biosphere (Campbell & Reece, 2008). Biology uses scientific methods to explore and understand life phenomena by involving scientific steps such as observation, data collection, experimentation, analysis, and drawing conclusions based on evidence (Mason et al., 2014). Therefore, the material contained in

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biology subjects can be a development of modern learning, such as ecosystem material, which is very relevant in this context. Understanding ecosystems is important to increase students' awareness of increasingly complex and urgent environmental issues. Therefore, a learning model which can increase students' understanding and active involvement is necessary.

The results of initial interviews conducted by researchers with the biology teacher at SMA Negeri 2 South Konawe obtained information that the inquiry learning model had never been used by teachers in the biology learning process, especially in ecosystem material. Biology learning at SMA Negeri 2 South Konawe still used a conventional teacher-centered model. The teacher focused more on providing explanations so the material can be conveyed completely. Based on documentation data, it is known that students' biology learning outcomes in ecosystem material so far have been sufficient. Only a few students do remedial to be able to pass. However, the teacher hopes that learning about ecosystem material will be more lively by exploring students' abilities in learning activities so that the teacher is no longer the center of learning and the only source of information. The teacher hope that students will be more active in biology learning activities so that it can also have a positive impact on their learning outcomes. Based on this information, the researcher recommends a learning model to meet the teacher's expectations.

The inquiry learning model has emerged as an effective solution in the modern learning context. It is 'a pedagogical approach in which students follow the inquiry-based processes used by scientists to construct knowledge' (Acar & Tuncdogan, 2018). This model encourages students to become active learners who are directly involved in searching and discovering information (Sa'diyah & Aini, 2022). It allows students to have more freedom during the learning process and can increase the quality of their classroom participation (Kersting et al., 2023). Through inquiry, students are invited to ask questions, formulate hypotheses, conduct investigations, and analyze and conclude the data obtained. This model is believed to not only improve conceptual understanding but also develop critical and analytical thinking skills, which can positively impact student learning outcomes.

Several recent studies show that the inquiry learning model positively impacts student learning outcomes. For example, research by (Ochoma, 2020) shows that students who learn using the inquiry model have a deeper understanding and can apply the concepts learned in real contexts. Likewise, a study by (Ülger & Çepnı, 2020) found that the inquiry approach increases students' learning motivation and problem-solving skills. Similarly, (Juliani, 2020) states that applying the inquiry model can improve the biology learning outcomes of grade X students on the sub-subject of environmental pollution (including the ecosystem material). These three studies focus on the significance of the inquiry learning model for modern learning objectives. The present study, thus, wants to look at it from a simple point of view, namely looking at the significance of the inquiry learning model on biology learning outcomes, especially on the ecosystem material.

While the inquiry learning model holds promise for improving student learning outcomes, its application is not without challenges. These include teacher unfamiliarity with the model, time constraints within the curriculum, and a lack of supporting resources. Therefore, it is crucial to conduct the present study to delve deeper into the influence of the inquiry learning model on the biology learning outcomes of grade X students, particularly in the context of the ecosystem material. The study also aims to explore strategies that can be employed to overcome these challenges, thereby making the application of the inquiry learning model more feasible.

The results of the present study will provide new insights for educators in implementing the inquiry learning model and contribute to efforts to improve the quality of biology learning

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in schools. It is also hoped that this research can help formulate education policies that are more responsive to the learning needs of the 21st century so that they can produce a generation that is not only academically intelligent but also has the awareness and skills to face global challenges.

RESEARCH METHOD

A. Types of Research

The present study is quantitative research, using a quasi-experimental method to investigate the influence of the inquiry learning model on biology learning outcomes on ecosystem material. The research was carried out in two classes: the control class receiving regular treatment of the conventional learning model (i.e. the direct instruction learning model) and the experimental class receiving inquiry learning model treatment.

B. Research Location and Time

This research was conducted at SMA Negeri 2 South Konawe from March to May 2023.

C. Research Population and Sample

The population of this research is all students of grade X MIPA SMA Negeri 2 South Konawe for the 2022/2023 academic year, which includes four classes. The sample for the study was selected from this population, with the following details.

Table 1. Population Study

Class	The Number of Student	Average Value of Daily Test *
X MIPA 1	29	78.40
X MIPA 2	30	76.56
X MIPA 3	29	78.45
X MIPA 4	30	75.55
Amount	118	

* : Average value of daily test on the previous material

(Data source: The Biology Teacher of Grade X MIPA SMA Negeri 2 South Konawe)

Based on population data, the research sample was determined using a purposive sampling technique, where the sample was selected with special considerations, namely the number of students and the similar average daily test scores; as a result, the grade X MIPA 1 and grade X MIPA 3 were selected. Next, the experimental and control classes were determined randomly with the assumption that both classes had students with homogeneous abilities, so it was decided that class X MIPA 1 would be the control class and class X MIPA 3 would be the experimental class.

D. Research Design

The present study used a non-equivalent control group design, as seen in Table 2.

Table 2. Research Design

Group	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_3	-	O_4

Information:

O_1	:	Pretest of experimental class
X	:	Treatment model of inquiry learning
O_2	:	Posttest of experimental class
O_3	:	Pretest of control class
-	:	There is no special treatment from researchers (i.e. using a conventional learning model: direct instruction)
O_4	:	Post-test of control class

(Abraham & Supriyati, 2022).

E. Techniques of Data Collection and Research Instruments

1. Tests;

The present study utilizes a pretest and posttest system to discern the differences in learning outcomes at the beginning and the end of grade X MIPA biology learning on ecosystem material. The test instruments can be seen in Table 3.

Table 3. Matrix of the Test Instrument

Indicator of learning	Cognitive Domain of Anderson & Krathwohl's Taxonomy
To mention of ecosystem components	C1
To describe relationships between biotic and abiotic components	C3
To explain the mechanism of energy flow in ecosystems	C4
To explain factors supporting ecosystem balance	C2
To analyze the relationship between ecosystem components and food chain in the surrounding environment	C4

2. Observations

Observations in the present study were carried out to know and interpret the implementation of the inquiry learning model in learning activities, as well as its influence on the biology learning outcomes of grade X students on the ecosystem material. The instrument for the observation technique is constructed based on the steps of the inquiry learning model, starting from the orientation stage to preliminary activities (giving apperception, motivation, learning objectives, delivering short material), core activities (formulating problems, formulating hypotheses, collecting data, testing hypotheses), and closing activities (giving feedback, concluding learning activities, carrying out evaluations, and advising upcoming material) (Sanjaya, 2016).

F. Techniques of Data Analysis

The present study uses descriptive and inferential statistical data analysis techniques. Descriptive statistical analysis was conducted to interpret biology learning outcome variables trends for grade X MIPA students in ecosystem material. Inferential analysis was carried out to calculate the normality test (uses the Kolmogorov-Smirnov model) and homogeneity test (uses the Fisher test model) as a prerequisite for analysis, and hypothesis test (used the t-test model) to interpret the effect of using the inquiry learning model on the biology learning outcomes of grade X MIPA students on ecosystem material. Then the t-test must be continued to test the level of effectiveness (n-gain) to be able to interpret the level of effectiveness/influence of providing the learning model, with the following conditions and criteria:

Percentage Conditions	Criteria
$0 \leq x < 40$	Ineffective
$40 \leq x < 55$	Less effective
$55 \leq x < 75$	Adequately Effective
$75 \leq x < 100$	Effective

(Melisa et al., 2024) .

RESULTS AND DISCUSSION

Descriptive Analysis

Table 4 provides a descriptive statistical analysis of students' biology learning outcomes on ecosystem material. The statistical analysis encompasses the experimental class, which applies the inquiry learning model, and the control class, which applies the conventional learning model (i.e. direct instruction).

Table 4. Pretest and Posttest Biology Learning Results for Experiment Class and Control Class Students

Statistics	Prettest		Posttest	
	Experimental class	**Control class**	**Experimental class**	**Control class**
Lowest Score	20	10	70	70
Highest score	50	50	90	80
Average (mean)	36.03	37.09	82.59	76.03
Variance	135.85	145.1	69.21	57.71
Standard Deviation	11.65	12.89	8.31	7.59

Table 4 shows that the average pretest score of both the experimental class and control class are similar. It implies that the students in the experimental and control classes have almost the same competencies, which is indeed suitable for a research sample class. Apart from that, the pretest results were also used to map the competencies possessed by students, where researchers can get a general idea of the concepts that students have understood and have not so that researchers could better prepare themselves to carry out better learning activities. Furthermore, it is known that the average post-test score in the experimental class is higher than the average post-test score in the control class. It shows that the treatment in the experimental class was more effective than in the control class. However, to further optimize the findings, researchers proceeded to inferential analysis.

Analysis Inferential

Normality test

Normality test results can be seen in Table 5.

Table 5. Normality Test Results for Biology Learning Outcomes on Ecosystem Material of Students Grade X

No	Class	D_{count}	D_{table}	Conclusion
1	Control class pretest	0.155	0.246	Normal
2	Control class posttest	0.238		
3	Experimental class pretest	0.169	0.246	Normal
4	Experimental class posttest	0.156		

Table 5 displays that the pretest and posttest scores showing students' learning outcomes for the control class and experimental class have lower D_{count} than the D_{table} value of 0.246, so it can be interpreted that H_0 is accepted where all data is normally distributed, and data analysis can proceed to the homogeneity test.

Homogeneity Test
Homogeneity test results can be seen in Table 6.
Table 6. Homogeneity Test Results for Biology Learning Outcomes on Ecosystem Material of Students Grade X

Stage	Class	F_{count}	F_{table}	Criteria
Pretest	Control	0.093	1,882	Homogeneous
	Experiment			
Posttest	Control	1,199	1,882	Homogeneous
	Experiment			

Table 6 shows that the pretest and posttest scores indicating students' learning outcomes for the control class and experimental class have a smaller F_{count} value than the F_{table} value of 1.882, so it can be interpreted that H_0 is accepted where all data is homogeneous, which means that the control class and experimental class come from a same variance population, or that the set of the learning outcomes data has the same characteristics so that data analysis can proceed to the hypothesis testing stage.
Hypothesis Testing
Hypothesis testing results can be seen in Table 7.
Table 7. Hypothesis Test Results for Biology Learning Outcomes on Ecosystem Material of Students Grade X

Learning Outcomes	T_{count}	T_{table}	Information
Pretest	1,736	2,003	There is no difference
Posttest	3,248	2,003	There is a difference

Table 7 shows that the value of the pretest hypothesis test results for experimental class and control class students is 1.736, which is smaller than the t_{table} value of 2.003. Based on these data, a decision can be made that H_0 is accepted, and that there is no difference in the biology learning outcomes of students in grade X MIPA 1 and grade X MIPA 3 before being given treatment. Furthermore, it is known that the value of the posttest hypothesis test results for experimental class and control class students is 3.248, greater than the ttable value of 2.003. Based on these data, a decision can be made that H_1 is accepted, and that there is a difference in biology learning outcomes for students in grade X MIPA 1 and grade X MIPA 3 after being given treatment (i.e. the inquiry learning model). However, to be able to interpret the influence/effectiveness of applying the inquiry learning model on the learning outcomes, data analysis was continued to the n-gain test stage.
N-Gain Test
N-gain test results can be seen in Table 8.
Table 8. N-Gain Test Results for Biology Learning Outcomes on Ecosystem Material of Students Grade X

Class	N-Gain Score	N-Gain Score Percentage	Category
Control	0.549	54.94%	Less effective
Experiment	0,748	74,82%	Adequately Effective

Table 8 shows that test results for the effectiveness level of applying the direct instruction learning model in the control class obtained an n-gain value of 0.549, with a percentage of 54.94%, which means that the direct instruction learning model given in the control class had some extent of effectiveness or influence on the biology learning outcomes for grade X students in the ecosystem material accounting for 54.94%. The remaining 45.06% were influenced by other variables not examined in the present study, so it was categorized as less effective. Furthermore, the test results for the effectiveness level of applying the inquiry learning model in the experimental class obtained an n-gain value of 0.748, with a percentage

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of 74.82%, which means that the inquiry learning model given in the experimental class had a level of effectiveness or influence on the biology learning outcomes for grade X students in the ecosystem material accounting for 74.82%, and the remaining 25.18% were influenced by other variables which were not examined in this research, so they were categorized as quite effective. Based on these two data, it can be concluded that the inquiry learning model has a positive and effective effect on the biology learning outcomes for grade X students in the ecosystem material.

The influence and effectiveness of the inquiry learning model on biology learning outcomes of grade X in the ecosystem material can also be seen in the implementation of the inquiry learning model during learning activities, which in detail can be seen in Table 9.

Table 9. Results of Implementing the Inquiry Learning Model Through Teacher and Student Activities

No.	Observed aspects	Score in Each Meeting			Total Score
		1	2	3	
1	Orientation				
	Teacher	1	2	2	5
	Students	1	2	2	5
2	Formulating problems				
	Teacher	1	2	2	5
	Students	1	1	2	4
3	Proposing hypotheses				
	Teacher	2	2	2	6
	Students	1	2	2	5
4	Collecting data				
	Teacher	1	1	2	4
	Students	1	1	2	4
5	Testing hypotheses				
	Teacher	2	2	2	6
	Students	1	2	2	5
6	Concluding learning activities				
	Teacher	1	1	2	4
	Students	1	1	2	4

Information:
Score 2 : Implemented
Score 1 : Less implemented
Score 0 : Not implemented

Table 9 shows that implementing the inquiry learning model on ecosystem material was not optimal even after three meetings in which every aspect observed in the inquiry learning model stage did not get maximum marks for both teacher and student activities. At the orientation stage, the teacher explained the material in detail. Especially at the initial meeting so that learning remains teacher-centered. It has shaped students' mindset that the information from the initial material still comes from the teacher, so students seemed to be not motivated to be independent. (Prasetiyo & Rosy, 2020) explain that the orientation in the first stage cultivates students' creativity so that they can process scientific activities independently and believe in their abilities. Therefore, teachers do not need to provide detailed explanations to students about the material and assignments so that students can have the desire to find out and find answers themselves without having to expect answers from the teacher. (Hidayati et al., 2017) add that the orientation stage in the inquiry learning model should be carried out to improve students' ability to find and connect concepts so that they can formulate a problem, which would be the next step. It means that the orientation stage determines the success of the next stage in the inquiry learning model.

The effects of the lack of implementation of the orientation stage can be seen in the completeness of the implementation of the next stage, namely the problem formulation stage. as (Sanjani, 2019) emphasizes, this stage is crucial in forming students' thinking patterns. It is where students are required to be able to simply study the phenomena displayed by the teacher, then create a resume about the strange things that occur in these phenomena so that various questions to resolve can arise. This process is very important in inquiry, because students will gain very valuable experience as an effort to develop their mental through the thinking process. In addition, (Lasaiba, 2023) suggests that in the context of biology learning, formulating problems can involve students in identifying ecosystem issues, such as the impact of environmental change on biodiversity or the relationship between species in the food chain. Through the formulation stage, students, thus, not only learn biological concepts but also learn how to apply knowledge to solve real problems, which ultimately increases the learning activity and outcomes.

The stages of proposing/creating and testing hypotheses were generally carried out well. The teacher and students could generally make temporary answers from the problem formulation created and could test the hypotheses using scientific principles appropriately. Based on the observation results, the teacher explained to students that the hypothesis formulation system is open-ended, where each student has the right to write a temporary answer to the problem formulation created based on initial understanding or logic. Meanwhile, testing hypotheses is based on scientific data collection techniques, where the results may or may not match the student's initial expectations. It makes students more comfortable and confident in carrying out the inquiry stages. (Indrawan et al., 2023) explain that when students formulate a hypothesis, students become more involved and motivated to test the hypothesis. Active involvement is very important in increasing student participation in learning and deepening understanding of biology material. In addition, (Rahmasiwi et al., 2015) explain that in biology learning, formulating a hypothesis can involve students in making predictions about experimental results, such as the influence of environmental variables on plant growth or interactions between predators and prey in the ecosystem. By formulating and testing these hypotheses, students can understand biological concepts more deeply and develop important scientific skills.

The most difficult stage in maximizing the implementation of the inquiry learning model is the stage of collecting data and concluding learning activities. Based on the results of observations, teachers had difficulty collecting data due to limited time for learning activities, which has an impact on exploring students' abilities to search and analyze their findings scientifically. The teacher was also unable to allocate the learning time appropriately. As a result, the concluding stage of learning activities could not be completed on time, and even several important things, such as material feedback and short evaluations, were missed. (Lepiyanto, 2014) argues that the data collection stage requires students to carry out careful observations and controlled experiments. It will help students develop important practical skills in biology, such as observing specimens, recording observations, and using laboratory equipment. Data collection activities will allow students to see how the theories they learn in class are applied in practical contexts. It makes learning more meaningful and helps students relate theoretical concepts to real-world applications. In addition, (Edlund & Balgopal, 2021) explain that drawing conclusions from data in the biology learning process has an important role in strengthening students' understanding of biological concepts. Analyzing data and drawing conclusions will make students learn to integrate various information and understand the relationship between these concepts, which positively impacts understanding concepts and learning outcomes.

However, (Torday & Baluška, 2019) suggest that although the inquiry learning model has many benefits, there are several disadvantages, especially in terms of time organization. Teachers need to have special skills to be able to facilitate inquiry learning effectively. Teachers must be able to guide students through complex processes, organize time, and ensure that each student has a meaningful learning experience. It requires adequate training and professional development. Additionally, students who are not used to using inquiry will definitely need more time to explore, formulate questions, collect data, and draw conclusions. Such a process can be challenging in a dense curriculum. Based on the recapitulation of learning activities during the inquiry learning model, it can be concluded that the teacher and students have not yet understood the inquiry optimally, but it can improve over time. It is important to acknowledge and work towards overcoming these challenges, as it will ultimately lead to a more effective and rewarding learning experience for the teachers and students.

CONCLUSION

Based on the findings and discussion, it can be concluded that: 1) the inquiry learning model has a positive effect on the biology learning outcomes of grade X students on the ecosystem material. The inquiry learning model has an effective effect of 74.82% in learning activities, and 25.18% is influenced by other variables which are not examined in this research, so it is categorized as quite effective; 2) the inquiry learning model applied to grade X students in the ecosystem material has difficulties in the learning activities, namely difficulties in orienting the material and formulating problems. The biggest difficulty faced by the teacher is collecting data and drawing conclusions, which is caused by the teacher's lack of ability to organize the learning time.

IMPLICATIONS AND SUGGESTIONS

The present study provides an overview for biology learning practitioners about using a different learning model suited to student characteristics and the characteristics of the ecosystem material, in which the inquiry learning model is appropriate to the characteristics of the ecosystem material and is effective in improving student learning outcomes. This research focuses on student learning outcomes, so researchers hope that other 21st-century competency variables, such as critical, creative, collaborative, and communicative thinking skills, can be tested to apply the inquiry learning model or other contextual and constructivist learning models so that they can be used as indicators of complex students' achievements in biology learning. In addition, the researchers hope that the teacher can develop their competence in understanding the inquiry learning model so that the implementation of learning can also be maximized.

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