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Improving Students' Critical Thinking Ability Through Guided Inquiry Model with Scientific Approach on Ecosystem Material

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Abstract

This study aims to determine the effect of a *guided inquiry* learning model with a scientific approach on students' critical thinking skills on ecosystem material. The research was conducted in the even semester of the 2023/2024 academic year at one of the high schools in Jakarta, Indonesia. The research method used was a quasi-experiment with *Nonequivalent Control Group Design. The* research sample used was 52 students, with each class totaling 26 students using a *simple random sampling* technique. Based on the study's results, the experimental class's average value was 87.27, and the control class was 80.15. The t-independent test results show that the guided inquiry learning model, with a scientific approach, affects students' critical thinking skills on ecosystem material. Applying a scientific approach to the guided inquiry learning model can allow teachers to train and improve students' critical thinking skills. This learning model and approach encourages active participation, stimulates curiosity, and helps students gain a deeper understanding.

Keywords: Critical Thinking, Scientific Approach, Guided Inquiry

INTRODUCTION

The world has entered the era of society 5.0, where all aspects of life are related to the internet and digital technology. This era emphasizes modern technology-oriented science (Indarta *et al.,* 2022). This has a significant impact in various domains of life, including social, economic, and cultural, especially in education (Parwati & Pramartha, 2021). In this era of education, students are required to master various abilities, one of which is the ability to think critically (Rahmawatii & Salehudin, 2021). Students' critical thinking skills are still relatively low. This is evidenced by the statistical data on Indonesia's PISA (Program for International Student Assessment) results in 2018, which decreased compared to 2015, ranking 73rd out of 79 countries participating in PISA (Tohir, 2019). In 2015, Indonesia ranked 45th out of 48 countries participating in TIMSS (Trends in International Mathematics and Science Study) (Saraswati & Agustika, 2020). This situation shows the need to improve students' critical thinking skills.

Low critical thinking skills can also impact student learning outcomes so by improving critical thinking skills, students can improve their learning outcomes (Lestari *et al.,* 2019). Fisher (2008) states that critical thinking is the ability to think deeply about problems and apply them in logical methods of investigation and reasoning. According to Oktariani & Ekadiansyah (2020), critical thinking is also a form of higher-level thinking that is very important in the learning process, where this ability can encourage students to evaluate

information and make decisions independently, concerning existing facts, situations, ideas, approaches, and criteria. In line with Wahyunita & Subroto's (2021) research, by having critical thinking skills, students can skillfully evaluate and formulate strong arguments to support each decision based on careful analysis and evidence. Based on the above statement, it can be concluded that critical thinking is the ability of students to analyze and evaluate information to make the right decision.

One of the learning processes that require critical thinking skills is the biology learning process because the concepts and theories in this subject are quite complex (Adinda *et al.,* 2022), so students must have critical thinking skills to understand and apply material concepts in different contexts (Fakhrizal & Hasanah, 2021). In the biology learning process, students still memorize learning material without being able to analyze and understand the learning material more deeply (Harahap *et al.,* 2020). Ecosystems are one part of biology learning material, which includes environmental problems and is closely related to everyday life (Andaresta & Rachmadiarti, 2021), so in learning activities, students are expected to be critical to be able to find solutions to environmental problems that often arise in the surrounding ecosystem (Mayasari & Muktiali, 2022). To achieve this, critical thinking skills are needed in ecosystem material so that students can analyze problems that can occur in everyday life (Damayanti *et al*., 2022). However, according to research by Harahap *et al.* (2020) critical thinking skills in ecosystem material are low because the concepts and theories of the material have a high level of complexity so students cannot analyze learning material and cannot relate concepts to everyday life.

Based on the above conditions, efforts to train and improve critical thinking skills, which can meet the demands of the era of society 5.0, namely by applying innovative learning models that are student-centered, encourage students to be able to analyze problems so that students become more active in learning activities (Mulyanti *et al.,* 2023). The learning model in question is the guided inquiry model, which is a model that requires students to actively participate in asking questions and finding their own answers so that it can stimulate student curiosity and allow students to hone their critical thinking skills (Prasetiyo & Rosy, 2020).

Learning activities that prioritize critical thinking skills also require a scientific approach (Limatahu *et al.,* 2019). This approach can further train students' critical thinking skills by encouraging students to be able to analyze, evaluate, and synthesize information (Liana, 2020). The scientific approach aims to teach students how to recognize and understand various materials with the awareness that information is not only obtained from the teacher, but can come from various other sources (Pada *et al.,* 2021). This study aims to

determine the effect of the guided inquiry learning model with a scientific approach on students' critical thinking skills on ecosystem material.

METHOD

This study was conducted in the even semester of the 2023/2024 academic year in one of the high schools in Jakarta, Indonesia. The method used in this research is *quasi-experimental*. The experimental class applied the guided inquiry learning model with a scientific approach, while the control class will be treated with the STAD (*Student Teams Achievement Division*) learning model.

The sample determination in this study used a *simple random sampling* technique, so 26 students were selected in each class with a total of 52 students, which were determined using the Federer formula. The instruments used include critical thinking ability test instruments and non-test instruments. These observation sheets are useful for examining the implementation of guided inquiry learning models using a scientific approach. The instrument grids can be seen in Table 1 and Table 2.

Table 1. Critical Thinking Instrument Grid

Aspects Critical Thinking	Indicator
Interpretation	Understand and interpret information or statements carefully
Analysis	Analyze and ascertain information related to the statement to solve the problem.
Inference	Conclude with strong and reasonable arguments in solving problems.
Evaluation	Evaluate the reliability of a statement or interpretation in solving a problem
Explanation	Provide explanations with strong and convincing evidence.
Self-Regulation	Evaluate statements or opinions related to the problem.

(Modified from Facione, 2020)

The critical thinking instrument is an 18-item essay test useful for measuring students' critical thinking skills.

Table 2. Instrument Lattice of Learning Implementation Observation Sheet

Guided Inquiry Stage	Scientific Approach
Orientation	Observing
Formulating the Problem	Observing, Questioning
Formulate a Hypothesis	Inquire
Collecting Data	Observing, Collecting data, Processing data
Testing the Hypothesis	Communicating, Questioning
Formulating Conclusions	Inquire

(Modified from Sanjaya, 2011; Daryanto & Karim, 2017)

The learning implementation in the experimental class consisted of four meetings, during which the guided inquiry learning model was applied with a scientific approach. In meetings 1 and 2, learning was implemented by applying all stages of the learning model. At meeting 3, the implementation of learning only consists of the orientation stage, formulating problems, and formulating hypotheses. In meeting 4, the implementation of learning only consists of the stages of orientation, collecting data, testing hypotheses, and formulating conclusions.

The data analysis techniques used include descriptive statistical analysis, *normalized gain (N-Gain) test*, prerequisite test, and hypothesis testing. The prerequisite test consists of a normality test using the *Kolmogorov-Smirnov test* and a homogeneity test using the *Levene* test with a significance level of $\alpha = 0{,}05$. Hypothesis testing used an *independent-sample t-test* with a significance level of $\alpha = 0{,}05$.

RESULTS AND DISCUSSION

Based on the student critical thinking ability test results after applying the guided inquiry learning model with a scientific approach, the average value of the experimental class was 87.27, and the control class was 80.15. This shows that the average increase in the experimental class is higher than in the control class. In accordance with the t-test results, which show a significance value smaller than $\alpha = 0.05$, namely $0.021 < 0.05$ so reject H_0 . The t-test results prove that the guided inquiry learning model, with a scientific approach, affects students' critical thinking skills on ecosystem material, which can be seen in Table 3.

Table 3. Descriptive Statistical Analysis of Critical Thinking Ability

Description	Experiment Class (Guided Inquiry with Scientific Approach)		Control Class (STAD)	
	Pretest	*Posttest*	*Pretest*	*Posttest*
Lowest Score	39	73	34	58
Highest Score	73	95	78	95
Value Range	34	22	44	37
Average	60,27	87,27	58,92	80,15
Standard Deviation	60,27 ± 9,65	87,27 ± 7,08	58,92 ± 12,23	80,15± 9,01
Variance	93,16	50,20	149,5	81,33
Sample Quantity	26	26	26	26

The high average increase in the experimental class can occur because, in this model and approach, students can be directly involved in learning. During the learning process, students look carefully at formulating problems and hypotheses and are active during discussions by providing opinions and suggestions. This statement is supported by the research of Ndruru & Harefa (2023), which states that more active students tend to have a better and deeper understanding. In line with the research of Harahap *et al.* (2020) the guided

inquiry model with a scientific approach can increase student participation, student cognitive abilities, and stimulate students' critical thinking skills.

The increase and high scores in the experimental class can also be caused by the syntax or stages of the guided inquiry learning model with a scientific approach, which can improve students' critical thinking skills (Indawati *et al.,* 2021). This statement is also supported by research by Muniroh *et al.* (2022), which shows that the syntax of the guided inquiry learning model can increase student confidence and enthusiasm in the learning process. In accordance with the opinion expressed by Adilah & Rosyida (2024), syntax in a learning model is an important aspect that can affect student learning outcomes or abilities.

The guided inquiry learning model has six stages or syntax, including orientation, formulating problems, formulating hypotheses, collecting data, testing hypotheses, and formulating conclusions (Sanjaya, 2011), while the scientific approach consists of several stages, including observing, questioning, collecting data, processing data, and communicating (Daryanto & Karim, 2017). These stages can train students to think analytically and critically.

Students' critical thinking skills are measured based on six indicators proposed by Facione (2020): interpretation, analysis, inference, evaluation, explanation, and self-regulation. The calculation of the average of each indicator of the critical thinking ability test shows that the average value of the highest indicator of the posttest in the experimental class is the analysis indicator, which can be seen in Table 4.

Table 4. Critical Thinking Ability Test Indicators

Indicator Critical Thinking	Experiment Class (Guided Inquiry with Scientific Approach)		Control Class (STAD)	
	Pretest	*Posttest*	*Pretest*	*Posttest*
Interpretation	70.00	86.54	69.62	93.85
Analysis	55.77	91.54	38.85	62.31
Inference	74.87	87.44	83.59	91.03
Evaluation	64.15	86.62	58.62	81.23
Explanation	45.96	88.65	41.35	74.42
Self-regulation	53.46	84.23	67.31	78.08

This shows that students have identified the relationship between concepts, statements or questions by using the guided inquiry model with a scientific approach. In accordance with Ramadhanti & Agustini (2021) research in guided inquiry learning with a scientific approach, the teacher will guide students in all learning activities. This can help students analyze the data obtained and obtain more credible information to improve their analytical skills. The above statement is also supported by Agustine *et al.'s (2020) research that states* that

individuals with good critical thinking skills can conduct a thorough analysis of the problems they face.

Meanwhile, in the control class, the highest average *posttest* score was on the interpretation indicator, where students can interpret and convey the meaning of various situations, data, events, and others without requiring a deep understanding of a concept and its relationship (Hidayati *et al*., 2021). The high interpretation indicator in the control class is because, in the STAD learning model, in group discussion activities, students will share their understanding and help each other understand the material presented by the teacher. This can strengthen students' ability to interpret information from various points of view so that students already had good interpretation skills during the post-test. Supported by Agustine *et al.* (2020) research that the high interpretation indicator is because students are only asked to describe the meaning and meaning of a concept.

In the lowest *posttest* average score in the experimental class, namely the self-regulation indicator. This shows that students are still less able to regulate or control themselves. The low indicator of self-regulation in the experimental class is because, during the learning process in the experimental class students will be guided by the teacher, so this can limit students' opportunities to organize the learning process independently. This situation can hinder students in developing their self-regulatory abilities. In the learning process in the experimental class, it was also seen that students were less able to control or manage the time of working on LKPD properly, where there were several students who took quite a long time to formulate the problem. That way, at the time of the *posttest the* self-regulation indicator had the lowest score. According to research by Winda & Hendro (2022), it states that self-regulation indicators are considered important in learning activities, because with this students can evaluate themselves, know the extent to which they master the material, and determine the actions to be taken in order to achieve optimal results.

The lowest average *posttest* score in the control class is the analysis indicator, this shows that by using the STAD learning model, students still have difficulty in analyzing and identifying relationships between concepts, statements, or questions. The low ability to analyze in the control class can also occur because students are too passive in learning activities, where students only do what the teacher tells them to do, without doing additional exploration of the problems faced in learning. This is supported by the research of Rismawati *et al.* (2023), that in the STAD learning model, teachers tend to only provide worksheets and materials without sufficient guidance, which can ultimately hinder the development of students' critical thinking skills. In line with Abdurahman's research (2023), the lack of guidance from teachers in the STAD model can occur because this model requires teachers to

work quickly in completing tasks related to the learning being carried out, such as checking student assignments or calculating the average group score at the end of each meeting, while learning time is also quite limited.

Based on the results of the calculation of the critical thinking ability category after the two classes were treated with different learning models, Table 5 shows that the critical thinking ability of students in the experimental and control classes is mostly in the very high category, but has a different frequency of students.

Table 5. Frequency of Students in Each Category of Critical Thinking Ability

Category	Value	Experiment Class		Control Class	
		Pretest	*Posttest*	*Pretest*	*Posttest*
Very High	81-100	0	22	0	14
High	61-80	16	4	12	10
Simply	41-60	9	0	12	2
Low	21-40	1	0	2	0
Very Low	0-20	0	0	0	0
Total		26	26	26	26

(Modified from Riduwan, 2011)

In the experimental class, 22 students had very high critical thinking skills, while in the control class, only 14 students. This shows that the guided inquiry learning model with a scientific approach affects students' critical thinking skills on ecosystem material. The results of the calculation of the critical thinking ability category are supported by Siahaan & Pane (2021) research that the guided inquiry learning model with a scientific approach positively impacts students' critical thinking skills.

Based on the Gain score calculation results, the experimental class obtained a higher value than the control class. This shows that the guided inquiry learning model with a scientific approach has a better impact than the STAD model in terms of improving critical thinking skills. Based on the *N-gain criteria, the* experimental and control classes fall into the medium criteria which refers to the criteria according to Sugiyono (2021), but the experimental class obtained a higher *N-gain* value than the control class. The criteria for the *N-Gain* value according to Sugiyono (2021) can be seen in Table 6.

Table 6. *N-Gain* Value Criteria

Average *N-Gain*	Interpretation
$g \geq 0{,}7$	High
$0{,}3 \leq g < 0{,}7$	Medium
$g < 0{,}3$	Low

(Sugiyono, 2021)

The high *N-gain* value in the experimental class is because, in the learning process the teacher does not completely release students, but there is guidance from the teacher that allows students with below-average abilities to continue to follow the learning process. In the learning process in the experimental class, students were also invited to collect data, identify the relationship between available information, and assess the truth and relevance of various evidence that students find, so that it can train students in developing their critical thinking skills. This is supported by Siahaan & Pane (2021) research that guided inquiry with a scientific approach can effectively improve students' critical thinking skills.

The high N-gain value in the experimental class proves that using the guided inquiry model with a scientific approach is more effective than the STAD model in improving critical thinking skills. The achievement of high *N-gain* values in the experimental class is inseparable from various factors, such as the conditions of teachers and students and the model applied during the learning process (Khoiri, 2021).

Based on the observation of learning implementation, the average percentage of learning implementation in the experimental class was 89.26% and the percentage in the control class was 87.26% (Table 7) so, the average percentage of learning implementation in the experimental class was higher than the control class.

Table 7. Learning Implementation Observation Results

Class	Meeting				Average
	1	2	3	4	
Experiment	100%	89,28%	90%	77,77%	89,26%
Control	90%	93,33%	80%	85,71%	87,26%

This shows that the teacher can implement the syntax of the learning model and manage the class well; besides that, students have also responded and can understand the entire syntax of the learning model well. This statement is supported by Aninda *et al.* (2020). Good learning implementation shows that the teacher has successfully managed the classroom environment and that the learning process is in accordance with the planned teaching module. In line with research Khartaningtyas & Rosdiana (2020), a good response from students will result in effective learning to improve learning outcomes and student abilities. The results of the observation of the learning implementation are also proven by Siahaan & Pane's (2021) research, that implementing the guided inquiry learning model with a scientific approach can develop *soft skills*, such as students' critical and analytical thinking *skills*.

CONCLUSION

Based on data analysis and hypothesis testing, it can be concluded that the experimental class using the guided inquiry learning model with a scientific approach obtained higher

scores than the control class. This can be seen from the average value of critical thinking skills in the experimental class obtained by 87.27 while the control class amounted to 80.15. The results of the *independent-sample t-test* test obtained a significance value smaller thanα = 0.05, namely 0.021 < 0.05 so reject H_0 . This proves that there is an effect of guided inquiry learning model with a scientific approach to students' critical thinking skills on ecosystem material.

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