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The Effectiveness of A Guided-Inquiry Learning Model Based On Biotechnology Practicum Materials in Improving The Learning Outcomes of High School Students

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Abstract

Prior learning of biotechnology material was carried out without the process of finding concepts by students. Learning is still centered on the teacher and does not involve student activity. So there is a need for learning that can be applied to improve understanding of concepts and student activities in learning. Theoretically, the *guided-inquiry* learning model can improve students understanding of concepts and active roles . The purpose of this study was to analyze the effectiveness of the *guided-inquiry learning model* based on biotechnology practicum material in improving high school student learning outcomes. The research design is *quasi-experimental* with *the nonequivalent control group design*. Cognitive aspects of learning outcomes were measured using *multiple choice test* sheets, analyzed using the N-gain test , *Wilcoxon test,* and *Mann-Whitney test* . Psychomotor aspects of learning outcomes were measured using *multiple choice test* sheets, analyzed using the t test; and observation sheet analyzed descriptive percentage. The teacher's response was measured with a questionnaire sheet instrument which was analyzed descriptively qualitatively. Students' responses and the implementation of learning were measured with a questionnaire sheet instrument analyzed descriptively percentage. The average N-gain cognitive aspect of the experimental class is in the medium category and the control class is in the low category. The results of learning cognitive aspects and skills based on student tests in the experimental class > control class significantly. Sixty nine percent of students are highly skilled and twenty eight percent are skilled. The teacher's response is that this *guided-inquiry* learning model makes it easier to emphasize concepts but there is a need for better class and time management. The response of the majority of students was good. All the learning steps of the experimental class were carried out, while in the control class the instructions recorded important points that were not conveyed. Conclusion, the *guided-inquiry* learning model based on biotechnology practicum materials in improving the learning outcomes of high school students.

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INTRODUCTION

Learning biology is not only by lecturing and taking notes, because certain biology materials are difficult to understand with text only (Jayawardana, 2017). Biotechnology includes material that emphasizes the application of students' understanding concepts. This is detailed in the 2013 curriculum for high school biology lessons that biotechnology is studied in class XII even semester. There are two KD (basic competencies) that students must achieve, namely KD 3.10 (Analyzing the basic principles of biotechnology and its application as an effort to improve human welfare), and KD 4.10 (Presenting reports on the results of experiments on the application of conventional biotechnology principles based on the *scientific method*). Based on these basic competencies, students should be directly involved, active, and critical in learning.

Based on the results of an interview with Mr. Suwargono (a biology teacher at SMA N 1 Kayen) It is known that learning biotechnology for the 2020/2021 school year only delivers material in the form of *power point slides* through the *Microsoft Team.* In addition, giving assignments to students is only via *WhatsApp* . So that learning is carried out without the process of finding concepts by students. The learning is centered on the teacher and students are not actively involved in learning. In accordance with the 2013 curriculum, biotechnology material contains a bill of trial results. So with this learning the KD bill has not been fulfilled.

The National Science Teacher Association in 2004 stated that understanding of science content can be significantly improved by *inquiry learning* (Shields, 2006). This model is also suitable to be applied to biotechnology material because it is in accordance with the 2013 curriculum which requires learning to be carried out using the *scientific method* . The type of *inquiry* chosen is *guided-inquiry* . In line with the research of Hubbi et *al.* (2017) that the *guided-inquiry* learning model not only encourage students to do scientific work , but also improve understanding of concepts . The *guided-inquiry* learning model can be carried out using various methods. To fulfill the bill of basic competency in biotechnology material, the practicum method is used. This statement is reinforced by Suryaningsih (2017) that using practicum activities for learning methods is seen as effective learning, because students are involved and play an active role.

RESEARCH METHOD

The research design is *Quasi-experimental* with *The Nonequivalent Control Group Design.* The research was conducted at SMAN 1 Kayen in the even semester of the 2021/2022 school year. The population of this study were all students of class XII-MIPA SMA Negeri 1 Kayen, with a sample of all students in class XII-MIPA 2 and class XII-MIPA 3 (36 students in each class). Sampling was done by *purposive random sampling technique* . The experimental class uses a *guided-inquiry* learning model based on practicum and the control class uses a two-way *centered learning model* (lecture without practicum). Data and data collection techniques are presented in Table 1.

Table 1 . Data and Data Collection Techniques

Data	Techniques	Instrument	Source	Data analysis	Obtain time
Cognitive aspect learning outcomes	Test	sheet (*multiple choice*)	Student	Quantitative descriptive (t test , N-gain, *Wilcoxon*, & *Mann-Whitney*)	Beginning & end of research
Psychomotor aspect learning outcomes	Test	sheet (*multiple choice*)	Student	Quantitative descriptive (t test)	End of research
	Observation	Observation sheet	Student	Percentative descriptive	Center of research
Teacher response	Questionnaire	Questionnaire sheet (description)	Teacher	Qualitative descriptive	End of research
Student response	Questionnaire	sheets (*checkboxes*)	Student	Percentative descriptive	End of research
Implementation of learning	Observation	Observation sheet	Teacher	Percentative descriptive	Early-end research

RESULTS & DISCUSSION

1. Cognitive Aspect Learning Outcomes

Based on the results of the t - test analysis, it is known that there is no significant difference in the initial abilities of the students in the experimental class and the control class. Based on the results of the analysis of *pre-test* and *post-test values,* it is known that the classical mastery of learning outcomes in the cognitive aspects of the experimental class increased 47% after learning, while the control class only 20%. Based on the results of the N-gain test analysis, it is known that the average increase (N-gain) in experimental class student learning outcomes better than the control class as presented in Table 2 .

Table 2 . Test Results N -gain Learning Outcomes Cognitive Aspects

N-gain criterion	Number of students (%)	
	Experiment class	control class
Tall	14	6
Currently	44	33
Low	42	61
Average N-gain value	0.34	0.26
Criteria	Currently	Low

Based on Table 2. it can be seen that the number of students in the experimental class whose N-gain was in the high and medium categories was more than the control class, namely 58%> 40% of the total number of students. This increase was due to practicum to support understanding of biotechnology. Students can prove or test the truth of the concept of biotechnology in real terms with practicum so that they understand it better. In line with the opinion of Ngatini (2022) that a good understanding of the concept of material influences the improvement in student learning outcomes.

The experimental class biotechnology learning was delivered verbally and visually by the students based on the practicum results and clarified again by the teacher. It is also equipped with continuous representation of students and teachers so that the material is conveyed completely and well. In the control class, the teacher conveys the entire material which includes understanding, principles, types, impacts, and their application which includes material tools and practical work methods for making biotechnology products. Control class students only study what the teacher conveys, so learning is limited and has an impact on students' lack of understanding and learning

experience.

Based on the results of the *Wilcoxon test analysis,* it is known that there is a significant difference between the average *pre-test* and *post-test scores* in the experimental class and the control class. Based on the results of the *Mann-Whitney* test analysis , it is known that the *guided-inquiry learning model* based on biotechnology practice material has a significant effect on improving student cognitive learning outcomes compared to the *teacher centered learning model* (lectures without practicum). This is in line with research Pratiwi *et al.* (2019) that the average learning outcomes of the experimental class using the *guided-inquiry learning model* with practicum are better than the average learning outcomes of the control class with expository learning.

2. Psychomotor Aspect Learning Outcomes Based on Tests

The results of the analysis of the psychomotor aspect of learning outcomes based on the test show that the number of students who obtain learning outcomes with the criteria of being skilled and highly skilled in the experimental class is more than the control class as shown in Table 3.

Table 3. Psychomotor Aspect Learning Outcomes Based on Tests

Learning Outcome Criteria Psychomotor Aspect	Number of students (%)	
	Experiment class	control class
Very skilled	36	14
Skilled	33	25
Skilled enough	25	36
Less skilled	6	22
Not skilled	0	3

In Table 3. It is known that the criteria for highly skilled students in the experimental class > control class. This is due to the direct involvement and high student learning activity. In the control class, students lack learning activities so their biotechnology skills do not develop well and their psychomotor aspects score is low. Based on the results of the t test analysis It is known that the *guided-inquiry* learning model based on practicum material on biotechnology has a significant effect on improving the learning outcomes of students' psychomotor aspects.

3. Psychomotor Aspect Learning Outcomes Based on Observations

The results of the analysis of psychomotor aspects of learning outcomes based on observations show that most students obtain very skilled criteria as presented in Table 4.

Table 4 . Psychomotor Aspect Learning Outcomes Based on Observations

Criteria for Learning Outcomes Psychomotor Aspects	∑students (%)
Very skilled	69
Skilled	28
Skilled enough	3
Less skilled	0
Unskilled	0

In Table 4. it can be seen that there were no students who got the results of learning the psychomotor aspect with the criteria of being less skilled and unskilled. So overall the experimental class students have acquired the skills that are part of the application of biotechnology material, especially conventional biotechnology. Students are able to design practicum for making tempeh, cheese, yogurt, tapai cassava, and bread properly and correctly. Practicum in the experimental class encourages students to reflect and evaluate learning processes and products. These activities lead to the addition of skills and learning experiences that have an impact on improving student psychomotor aspects of learning outcomes.

4. Teacher Response

Based on the results of the teacher's response analysis it is known that overall, the teacher gave a positive response to the implementation of the guided-inquiry learning model based on practicum on biotechnology material which is presented in Table 5.

Table 5. Teacher Responses to the Implementation of Learning with the *Guided-Inquiry Model* Based on Practicum on Biotechnology Materials

No.	Main question	Teacher response
1.	Impression	It really helps students to increase their understanding of biotechnology material and create an interesting learning atmosphere
2.	convenience	It is easier for the teacher to emphasize material whose concept is not correct
3.	Difficulty	Conditioning when presenting and the influence of network signals
4.	Interest	Very interested, more on target because children can find understanding directly through discovering their own concepts
5.	Criticism and suggestions	Criticism: limited time management of the learning process Suggestion: can actually manage time in the learning process and is well controlled by the teacher

In Table 5. it can be seen that the learning model Practicum-based *guided-inquiry* can help students improve their understanding of biotechnology material , as well as create an interesting learning atmosphere. In line with the statement of Indriwati *et al.* (2018) that students who are given the opportunity to find out, discover, and prove themselves directly make them understand the concept better , are interested in following the lesson to the end, and will enjoy the learning process.

Things that need to be considered in the application of this model are time management and class mastery so that learning is effective. In line with the opinion of Wiguna *et al.* (2018) that student conditioning and management of learning time allocation are important to do carefully for success (attaining learning objectives) .

5. Student Response

Based on the results of the analysis of student responses, the majority of students gave positive responses to the implementation of learning using the *guided-inquiry model* based on practicum on biotechnology materials as presented in Table 6.

Table 6. Student Responses to the Implementation of Learning with the Practicum-Based *Guided-Inquiry* Learning Model on Biotechnology Materials

Student Response Criteria	The number of students	Percentage (%)
Very good	16	44
Well	20	56
Pretty good	0	0
Not good	0	0
Not good	0	0

In Table 6. it can be seen that all students gave responses with good and very good criteria. When learning, students show a good attitude and impression. Among them, students are very enthusiastic and interested in carrying out each stage of learning which is marked by giving each other opinions. There were 67% of students who agreed that the practicum-based *guided-inquiry* model was interesting and made it easy to apply biotechnology material to life .

6. Implementation of Learning

The learning steps carried out by the teacher as a whole are in accordance with the learning implementation plan (RPP). All the experimental class learning syntax was carried out. In the control class, instructions noted that important points were not conveyed, but these things did not have a fatal impact on student learning outcomes because they only served as learning supports.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the *guided-inquiry* learning model based on biotechnology practicum material is effective in improving high school student learning outcomes. The average N-gain cognitive aspect of the experimental class is in the medium category and the control class is in the low category. The results of learning cognitive aspects and skills based on student tests in the experimental class > control class significantly. Based on observations, the majority of experimental class students are skilled and highly skilled. The teacher's response is that this *guided-inquiry* learning model makes it easier to emphasize concepts but there is a need for better class and time management. The response of the majority of students was good. All the learning steps of the experimental class were carried out, while in the control class the instructions recorded important points that were not conveyed.

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