Indonesian Journal of Biology Education
Vol. 7, No. 1, 2024, pp: 7-14
pISSN: 2654-5950, eISSN: 2654-9190
Email: ijobe@untidar.ac.id
Website: https://journal.untidar.ac.id/index.php/ijobe/index

Bioentrepreneurship Learning Implementation: Improvement of Students' Critical Thinking Skills

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Article History
Received : 27 – 03 – 2024
Revised : 18 – 04 – 2024
Accepted : 25 – 04 – 2024

Keywords:
Bioentrepreneurship, Critical Thinking Skills, Project

Article link

Abstract

Critical thinking skills are needed by students to solve problems in real life, such as environmental problems related to waste in the environment around students. The purpose of this study is to improve students' critical thinking skills through bioentrepreneurship learning. This research is Classroom Action Research (CAR), consisting of two cycles, where each cycle includes planning, implementing, observing, and reflecting stages. The subjects involved in this research are students of study program X of Jombang X University class of 2020. Data collection techniques are carried out through observation and tests. This study used instruments in the form of observation sheets and critical thinking skills assessments in the form of description questions. The data is analyzed in a qualitative, descriptive way through the calculation of the average score obtained. The conclusion of the research results is that there is an increase in the average critical thinking skills of students through the implementation of bioentrepreneurship learning with project activities from cycle I to cycle II. In cycle I, students' average critical thinking skills were 2.89 with the criteria of "still underdeveloped," and in cycle II, they were 3.33 with the criteria of "well developed".

Introduction

To be able to face the 21st century, the education system must be directed not only to the transfer of knowledge but also to be able to form quality human resources and have the competencies needed in the 21st century (Hayati & Kuswanti, 2021). One of the 21st-century competencies students need is critical thinking skills (Bensley & Spero, 2014; Trilling & Fadel, 2009). Critical thinking skills involve logical thinking, which is indispensable for learners in solving problems in everyday life (Facione, 2015; Wulandari et al., 2020).

Results of previous research conducted by Hayati et al. (2019), Hayati & Berlianti (2020), and Hayati & Kuswanti (2021) show that students' critical thinking skills in one of the X university study programs in Jombang are still underdeveloped. The results of the preliminary test of critical thinking skills for students in the 2020 class in the same study program also show that students' critical thinking skills still need to be developed. Another study conducted by Hayati and Nuriyah (2023) on students in one of the schools in Jombang also showed the lack of development of students' thinking skills. This is especially true in learning, which leads to solving problems related to the surrounding environment.

Based on the explanation of Mitrevski and Zajkov (2012), critical thinking is a complex mental activity that involves higher-order thinking skills to solve problems, make decisions, and draw conclusions.

Furthermore, Abbasi and Izadpanah (2018) explained that critical thinking is one of the goals of the education system, which is to encourage students to succeed in their education. Students who have good critical thinking skills will not absorb information from the environment just like that. They think about how they are used and learn from other points of view to make the best decision to solve the problem.

In addition to critical thinking, entrepreneurship is another skill that needs to be possessed in the 21st century (Trilling & Fadel, 2009). In this case, Pal'Ová et al. (2020) explained that educational institutions have an important role in developing their learners' entrepreneurial skills. Furthermore, Hadzigeorgiou et al. (2012) said that science learning provides opportunities for the development of 21st-century skills, including entrepreneurial skills. Entrepreneurship is important to teach because it can produce independent graduates who can build personal businesses (Ejilibe, 2012). Shahiwala (2017) further conveyed that entrepreneurial skills are very important, not only to shape the younger generation's mindset but also to create opportunities and stimulate the economy.

Within a narrow scope, students studying in pesantren must be equipped with a variety of knowledge and skills not only related to religious science but also skills that will prepare them to face life's challenges after graduation. In 2007, the National Center on Education and the Economy explained that humans must have skills to face increasingly complex life and work environments (NCEE, 2007).

A learning model that has the potential to empower critical thinking and entrepreneurial skills is bioentrepreneurship. Bioentrepreneurship is biology-oriented learning oriented towards entrepreneurship. Bioentrepreneurship includes contextual learning, where learners get real experience through this learning (Kadir, 2013; Prihatiningrum et al., 2020; Santoso, 2017). The advantage of bioentrepreneurship learning is that the learning process is oriented to students' skills, fosters entrepreneurial spirit, and provides opportunities for students to learn about producing products (Hayati & Harmoko, 2023).

Bioentrepreneurship is a learning approach whose implementation needs to be combined with other learning models, such as project-based learning. In this learning model, students are directed to produce projects (Santoso et al., 2023). Bioentrepreneurship can be implemented in organic waste processing activities in the form of vegetable and fruit waste. In its implementation, students can be directed to carry out projects that produce products. The end product of waste processing is commonly called eco enzyme. Students can then process these products into a business product with economic value (Hayati & Fitriyah, 2021).

Based on this presentation, it is necessary to research to improve students' critical thinking skills through bioentrepreneurship learning. The research was conducted mainly on students at one of the universities in Jombang based on pesantren and entrepreneurship.

Methods

This study uses classroom action research, which is applied in as many as two cycles, each with stages: planning, implementing, observing, and reflecting. This study aims to improve students' critical thinking skills.

The subjects of this study involved 15 students of the study program X Universitas X Jombang class of 2020. This research was conducted in the even semester of 2022-2023 in the Biochemistry course. The instruments used are learning implementation sheets and critical thinking skills assessment sheets containing five-item description questions. The questions about the instruments prepared were validated before use. Data on the implementation of the learning model is obtained from observations by observers.

Indicators of critical thinking skills are measured in the form of truth and interrelationships between concepts, clarity of arguments, reasons that support or refute, flow of thinking, evaluation of evidence that can be logical, and grammar. Assessment of critical thinking skills using assessment rubrics developed by Zubaidah et al. (2015) from the Illinois Critical Thinking Essay Test and Guidelines for Scoring the Illinois Critical Thinking Essay Test by Finken and Ennis (1993). In observing activities in the classroom, researchers involve observers.

Data processing was analyzed in a qualitative, descriptive manner by comparing the average critical thinking skills of students in cycles I and II. The indicators of student critical thinking skills scores obtained based on the rubric in this study use a score range of 0-5. After obtaining the score, the criteria are determined based on the score range in Table 1.

Table 1. Range of Critical Thinking Skills Score Achievement Indicators

Range of Indicators	Critical Thinking Skills Criteria
0-2	Not yet visible or still underdeveloped
3-5	Well developed

(Source: Zubaidah et al., 2015 adapted from Finken & Ennis, 1993)

Results and Discussion

This research begins with observing learning in class to obtain an overview of the problems that arise. The data obtained in cycles I and II are described as follows:

Cycle I

Cycle I consists of planning, implementing, observing, and reflecting. Cycle I consists of two meetings.

Planning Stage

At this stage, researchers design learning devices and research instruments. Learning tools include semester lesson plans, lecture event units, and student worksheets.

Implementing Stage

This stage involves the implementation of bioentrepreneurship learning with a project-based learning model. The project task given to students was to manufacture ecoenzyme as a business product. The first meeting discussed enzyme-related topics, which were carried out according to the lecture schedule in class. At the second meeting, students made a business plan in the form of an ecoenzyme.

Observing Stage

At this stage, learning observation is carried out. Researchers, assisted by observers, make observations on implementing bioentrepreneurship learning. The observations illustrate the enthusiasm of students for participating in learning. Some of the shortcomings found during the implementation of learning are explained as follows.

a. Some students still lack concentration during learning.
b. Some students divided into three groups have difficulty designing business plans related to ecoenzyme.
c. Students still experience confusion when compiling project titles so as to submit questions to lecturers.
d. Students actively cooperate in completing activities.

Reflecting Stage

This stage contains learning reflection activities carried out. The purpose of reflection is to improve learning deficiencies in cycle I. From reflection activities, the following findings were obtained:

a. Students need to be directed toward learning. Therefore, lecturers give an approach to students lacking concentration.
b. Students still need lecturer guidance when completing assignments in class.

Furthermore, at the end of the first learning cycle, students take tests related to the material that has been discussed. The aim is to assess students' critical thinking skills. After the reflection activities, cycle I is continued by cycle II, where the stages are the same as cycle I, which contains planning, implementing, observing, and reflecting. The stages of cycle II learning are explained as follows.

Cycle II

Like cycle I, cycle II also consists of planning, implementation, observation, and reflection stages. Cycle I consists of two meetings.

Planning Stage

In this stage, learning devices and research instruments are designed. At this stage, lecture event units and student worksheets are prepared, while semester lecture plans have been prepared at the planning stage of the cycle I.

Implementing Stage

This second stage is the application of bioentrepreneurship to project tasks. Students continue to work on project assignments that involve making enzymes. The first meeting was held in the laboratory in the form of ecoenzyme manufacturing activities, while the second meeting was in the form of reporting on business activities that had been carried out. The picture of the implementation of learning in cycles I and II is described in Table 2.

Observing Stage

Similar to cycle I, in the observing stage, researchers observe learning assisted by observers. From the observations, it is known that students are enthusiastic about participating in learning.

a. Students actively cooperate in making ecoenzymes.
b. Students can complete activities well.
c. Students focus more on completing assignments with group members.
d. Learning steps can be carried out properly.

Reflecting Stage

The reflecting stage is in the form of reflection on the learning that has been carried out. Furthermore, at the end of learning, students again take the test to test their critical thinking skills in cycle II. In addition, the products produced by students from project assignments are also assessed. After

obtaining data on critical thinking skills, the data was analyzed by comparing the average scores in cycles I and II.

Table 2. Implementation of Learning in Cycles I and II

Bioentrepreneurship Steps through Project-based Learning	Learning Activities	Learning Implementation			
		Cycle I		Cycle II	
		Meeting 1	Meeting 2	Meeting 1	Meeting 2
Start With the Essential Question	Asking questions in the form of problems related to enzymes in everyday life.	√	√	√	√
	Guiding students to investigate the topics studied	√	√	√	√
Design a Plan for the Project	Guiding students to develop business product plans	-	√	√	-
	Guiding students to design the necessary resources	-	√	√	-
Create a Schedule	Guiding students in creating a timeline to complete projects	-	√	√	-
Monitor the Students and the Progress of the Project	Guiding students in reporting the progress of projects carried out	-	√	√	-
Assess the Outcome	Guiding students in presenting projects that have been done	-	-	-	√
	Assess the results of projects undertaken by students.	-	-	-	√
Evaluate the Experience	Guiding students to reflect on project completion activities	-	-	-	√

(Source: Author's document, 2023)

Students' Critical Thinking Skills

After the implementation of cycles I and II, the next step is to calculate students' average critical thinking skills to determine whether there is an increase from cycle I to cycle II based on critical thinking skills assessment sheets. The data analysis results showed an increase in the average score of critical thinking skills from cycle I to cycle II. The average improvement of students' critical thinking skills is presented in Table 3 and Table 4.

Table 3. Critical Thinking Skills of Students in Cycle I

No.	Student Code	Score	Criterion
1	AA	3,5	Well developed
2	SL	3,33	Well developed
3	AF	3	Well developed
4	DH	2,5	Still Underdeveloped
5	EI	3,16	Well developed
6	DA	3,16	Well developed
7	IM	2,16	Still Underdeveloped
8	SU	3,33	Well developed
9	SA	3,5	Well developed
10	SZ	2,33	Still Underdeveloped
11	RN	1,67	Still Underdeveloped
12	QU	3	Well developed
13	QA	2,67	Still Underdeveloped
14	MF	2,83	Still Underdeveloped
15	SN	3,33	Well developed
Average		**2,89**	**Still Underdeveloped**

(Source: Author's document, 2023)

Table 4. Critical Thinking Skills of Students in Cycle II

No.	Student Code	Score	Criterion
1	AA	3,33	Well developed
2	SL	3,67	Well developed
3	AF	3,33	Well developed
4	DH	3,16	Well developed
5	EI	3,33	Well developed
6	DA	4,33	Well developed
7	IM	3,16	Well developed
8	SU	3,5	Well developed
9	SA	3,16	Well developed
10	SZ	3,16	Well developed
11	RN	2,83	Still Underdeveloped
12	QU	3,67	Well developed
13	QA	3	Well developed
14	MF	2,83	Still Underdeveloped
15	SN	3,5	Well developed
Average		**3,33**	**Well developed**

(Source: Author's document, 2023)

Based on Table 3 and Table 4, it is known that there was an increase in critical thinking skills scores from cycle I to cycle II, where in cycle I it was 2.89 with the criteria of "still underdeveloped" and in cycle II it was 3.33 with the criteria of "well developed". The score of critical thinking skills achieved in the second cycle is still not classified as high, so this still has to be improved considering the importance of critical thinking skills for students. As explained by Prayogi et al. (2018), critical thinking is one of the skills students need to have. This is because critical thinking is associated with significantly improving the academic ability of learners (Abbasi & Izadpanah, 2018; Fitriani et al., 2020; Hayati et al., 2019; Hayati & Kuswanti, 2021; Husnah, 2017; Permana et al., 2019; Setiawati & Corebima, 2017; Vierra, 2014).

Hayati et al. (2019) explained that someone who has high academics is more likely to have good abilities in evaluating and analyzing their abilities. Thus, someone will be motivated to critically analyze the information that has been obtained, for example, by analyzing certain problems. The existence of critical thinking skills makes students equipped to solve everyday problems (Facione, 2013). Irwan et al. (2019) also explained that students who think critically tend to be able to think logically and systematically and are confident in solving problems. Furthermore, Wulandari et al. (2020) said that increasing the ability to solve problems logically and reflectively is very useful for students when facing problems.

Efforts to improve critical thinking can be achieved through constructivist learning (Hayati & Kuswanti, 2021). In addition, learning by presenting problems can also improve students' critical thinking skills (Handayani, 2016; Kurniahtunnisa et al., 2016; Ritonga et al., 2021). Bioentrepreneurship learning through projects is one of the things that leads to a constructivist approach. One project activity that can be carried out is making enzymes. Bioentrepreneurship is the learning of biology that leads to entrepreneurial activities. In learning, bioentrepreneurship can be integrated with project implementation. Students are faced with problems that exist in everyday life, such as the problem of organic waste in the form of vegetable and fruit waste. In biochemistry courses, topics can be taken in applying bioentrepreneurship through project assignments. The project is carried out by processing organic waste from vegetable and fruit residues through a fermentation process. The fermentation process finally produced useful products, such as liquid fertilizers.

From every step of learning carried out, students are trained to solve problems in the form of organic waste and then find solutions by designing a project to process organic waste into useful products. This activity involves critical thinking skills, as stated by Mitrevski and Zajkov (2012). Critical thinking is a complicated mental activity that requires higher-order thinking skills in solving problems, drawing conclusions, and making decisions. Furthermore, Bustami et al. (2019) and Zulfaneti et al. (2018) also explained that critical thinking skills relate to the processes of strategic planning, decision-making, scientific processes, and problem-solving to get solutions.

Bioentrepreneurship learning contains several advantages and disadvantages, based on the presentation of Hayati and Harmoko (2023). Here are the advantages of this learning: 1) provide opportunities for students to learn about the process of processing materials into products that have economic value and are useful; 2) foster enthusiasm for entrepreneurship; 3) optimize the potential of students in producing products; 4) describe the competencies that exist in students; 5) the learning process is more directed at the skills of students (life skill-oriented). Some of the disadvantages of the

bioentrepreneurship learning method are: 1) it takes a long time; 2) it requires patience in carrying out the learning steps; and 3) often the experiments carried out are not always in accordance with the desired results because they are influenced by certain factors that educators cannot control.

Conclusions and Recommendations

Conclusions are the answers to the research questions that are presented briefly and clearly. Conclusions can be written as descriptions in paragraphs or in points. Meanwhile, suggestions contain recommendations to the readers or researchers in related fields. Suggestions are written based on the results of research and discussion. If any, the limitations of research can also be one of the points of the authors' recommendations for further research to improve, complete, or perfect. The results of the study concluded that there was an increase in the average critical thinking skills of students through the implementation of bioentrepreneurship learning with project assignments from cycle I to cycle II. In cycle I, students' average critical thinking skills were 2.89 with the criteria of "still underdeveloped," and in cycle II, they were 3.33 with the criteria of "well developed".

Acknowledgement (optional)

Through this article, the author thanks Universitas Hasyim Asy'ari Tebuireng Jombang for providing funding for this research with contract number 062/LPPM-UNHASY/V/2023.

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