Misconception of the biology education students on the concepts of fermentation

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Abstract. Fermentation is one of the technologies in biotechnology to produce biotech products that are rich in nutritional content and have better quality. Survey data shows that students responding to biotechnology courses are one of the subjects that are difficult to understand and difficult to practice. Therefore, researchers tried to analyze the misconceptions that occurred in students who had studied biotechnology courses on the concepts of fermentation technology and fermentation products. The research approach is qualitative with the research method used is descriptive. The study population was students of Biology Education Sekolah Tinggi Keguruan dan Ilmu Pendidikan (STKI) Persada Khatulistiwa Sintang and the samples used were 36 students who has studied biotechnology. The technique of collecting data with diagnostic tests in the form of multiple choices and interviews. Analyze data using Certainty Of Response Index (CRI) and descriptive. The results of the research obtained are misconceptions on the concept of 34.44% fermentation technology and the concept of fermentation products by 34.26%. From these data it is known that quite a number of Biology Education students experience misconceptions.

1. Introduction
Fermentation is a form of application or the oldest application of the field of biotechnology and it is the process of converting organic material into another more useful form that is helped by microorganisms in a controlled manner. The microorganisms involved are bacteria, protozoa, fungi or kapang or fungus and, ragi or yeast. The examples of fermentation are the process of tape, tempe, soy sauce, wine, bread, asestat acid, cheese, and yogurt. To produce a particular fermentation product, it takes fermentation conditions and types of microbes with certain characteristics as well. In addition, it needs environmental conditions, substrates (media), as well as appropriate treatment so that the resulting product becomes optimal. Considering the importance of this fermentation product, it is necessary to be taught to the students about the concept of fermentation.

The recent problems is in understanding the theory on biotechnology learning not all students understand the concept of fermentation or it can be said that many students also feel difficulties in understanding about fermentation. The data of survey at STKIP Persada Khatulistiwa Sintang, Indonesia in 2018 showed that students consider the course of biotechnology is one of the elusive courses. Therefore, researchers are interested in seeing the depth understanding of biotechnology materials among students. Each student has different understanding on a concept. It caused by the student who has different ways of building their knowledge [1].
Misconception is a concept that is not in accordance with the scientific understanding or understanding that experts receive in that field [2]. Misconceptions can be in the form of early concepts, incorrect relationship between concepts, intuitive ideas or false views [3]. One of the causes of low mastery of concept is the presence of misconceptions and learning conditions that are less concerned with the initial conception (preconception) that students have. [4] reveals that if this misconception is highly resistant to revision, so it would be a problem for further scientific knowledge, therefore it is very important to specify it properly. The misunderstanding that happens to the students is one of the important factors that play a role in inhibiting the understanding of concepts. Misunderstanding is an inconsistency of understanding between the views of students and scientists [5].

According to [6] misconceptions experienced by students can occur because they misinterpret natural phenomena or something happened in their lives. Misconceptions that have been obtained by students at school still remain in him until he is in college. Misconceptions usually develop along the learning process. Several studies shown that misconceptions experienced by students do not only occur in the concepts of photosynthesis and plant respiration. Misconceptions in students also occur in the concepts of Ecology, Genetics, Living Creature Classification, and Circulation Systems [7]. Misconceptions in students who appear continuously can interfere the formation of scientific conceptions.

[8] states that misconceptions are stable cognitive structures change, affect students' understanding of scientific concepts, and must be addressed so students learn scientific concepts effectively. Many researchers have also found student misconceptions in biological concepts, one of them found when some students described biological examples of energy flows (including photosynthesis and cellular respiration), they provided a simple description of this process but could not describe their functions or correlation to each other [9]. There are many studies that show that students' misconceptions have a considerable influence on student learning about basic science concepts and subsequent concepts. Therefore, identification of student misconceptions is very important for effective teaching planning and improving student difficulties in understanding science concepts [10, 11, 12].

In this study the biotechnology concepts studied are fermentation technology and fermentation products. Where the questions are covering these concepts to express misconceptions from students. The purpose of the study is to express how much misconception students experience in the concept of fermentation technology and fermentation products.

2. Methods
The approach used in this study is qualitative research approach with a descriptive qualitative method. The data were collected by using multiple choice diagnostic tests and interviews. On each question items of the multiple choice diagnostic tests, students were asked to choose the answer that is considered the most correct by completing the table of certainty. Furthermore, interviews were conducted with students who experienced misconceptions to find out the cause of their misconception. The diagnostic test instrument was first tested to determine its validity, reliability, level of difficulty, and discrimination power.

The population in this study were all students who had taken biotechnology courses in STKIP Persada Khatulistiwa. The participants of this study were 36 students who were selected through simple random sampling technique. Analysis of misconception data in this study was carried out according to the CRI analysis conducted by [1]. CRI is a measure of the confidence or certainty level of the respondent while answering each question given. CRI is developed on a scale of six (0 - 5) as in Table 1.
Table 1. CRI and its criteria

| CRI | Criteria                          |
|-----|----------------------------------|
| 0   | (Totally guessed the answer)     |
| 1   | (Almost guess)                   |
| 2   | (Not Sure)                       |
| 3   | (Sure)                           |
| 4   | (Almost certain)                 |
| 5   | (Certain)                        |

In order to clarify the assessment, the following information (Table 2) will provide explanation on the provisions for distinguishing between understanding of concepts, misconception, and not knowing the concept for individual respondents.

Table 2. CRI Analysis Based on Answers Criteria

| Criteria of Answers | Low CRI (CRI < 2.5) | High CRI (CRI > 2.5) |
|---------------------|---------------------|----------------------|
| Correct Answer      | Correct answer with low CRI reflects that participants does not know the concepts (Lucky guess) | Correct answer with high CRI reflects that the participants have mastered the concepts |
| False Answer        | False answer with low CRI reflects the participants do not know the concept (Lucky guess) | False answer with high CRI reflects that participants hold misconception |

Subsequent to categorization, the percentage of each criterion is calculated using the following formula:

\[
\text{Percentage of X} = \frac{X}{N} \times 100\%
\]

\[
\text{Percentage of Y} = \frac{Y}{N} \times 100\%
\]

\[
\text{Percentage of Z} = \frac{Z}{N} \times 100\%
\]

Description:

- \(X\) = Number of students who know the concept
- \(Y\) = Number of students who do not know the concept
- \(Z\) = Number of students with misconceptions
- \(N\) = Total number of students

In order to investigate the cause of misconception, interviews were conducted with several participants who experience misconceptions.

3. Result and Discussion

Based on the analysis of misconceptions hold by 36 respondents regarding the fermentation technology and fermentation products concepts through CRI method, it is found that many participants hold different misconceptions regarding the biotechnology concepts. Analyzing student misconceptions by using CRI is to scrutinize students test result by checking their answers to multiple-choice test items and the CRI scale given in each test items. The combination of students answer and the CRI scale provided by students were then compared with the provisions, in order to determine whether or not students were experiencing misconception. The result of analysis on students response regarding the fermentation technology, several students with misconception were found (Table 3).
Table 3. The results of misconception analysis on the Fermentation technology

| No | Criteria | The number of students | Number of questions | Score | Average | Percentage (%) |
|----|----------|------------------------|---------------------|-------|---------|----------------|
| 1  | X        | 36                     | 15                  | 219   | 14.6    | 40.55%         |
| 2  | Y        | 36                     | 15                  | 135   | 9       | 25%            |
| 3  | Z        | 36                     | 15                  | 186   | 12.4    | 34.44%         |

Analysis of misconception on the concepts of fermentation products which consists of 15 question items was also carried out. The result of data analysis also showed that there were students who know the concepts (X), students who don’t know the concepts (Y), and also students who hold misconception (Z) regarding fermentation products (Table 4).

Table 4. The results of misconception analysis on fermentation products

| No | Criteria | The number of students | Number of questions | Score | Average | Percentage (%) |
|----|----------|------------------------|---------------------|-------|---------|----------------|
| 1  | X        | 36                     | 15                  | 174   | 11.6    | 32.22          |
| 2  | Y        | 36                     | 15                  | 181   | 12.06   | 33.52          |
| 3  | Z        | 36                     | 15                  | 185   | 12.33   | 34.26          |

In addition to the use of multiple choice tests, interviews were also conducted to investigate the reasons behind students answers. Five students who were chosen to be interviewed are those who hold misconception about the fermentation technology and fermentation products on different question items. The result of interview showed that students’ misconceptions regarding the fermentation technology and fermentation products concepts were caused by several factors, including the previously obtained information from their peers, teachers, television, internet, books, or other references. The previously obtained concepts that they obtained can be persistent, despite being inconsistent with the currently accepted concepts of science.

Based on data from the research results in Table 3 and Table 4, it can be seen that both the concepts of fermentation technology and fermentation products have quite a number of students who experienced misconceptions. this is because there are allegedly several causes of students experiencing misconceptions. The researchers of misconceptions stated that various things that were the cause of misconceptions in students. Broadly speaking, the causes of misconception can be summarized in five groups, namely: students, teachers, textbooks, constellations, and teaching methods. The students’ errors cause consist of various things, such as preconceptions, abilities, stages of development, interests, ways of thinking, and friends. The teachers’ errors cause consist of teacher’s inability, lack of mastery of material, improper teaching methods or uncomfortable relationship between teachers and students. Contexts, such as everyday culture and language also influence student misconceptions. While the teaching method which only emphasizes the truth of one aspect often leads to misunderstanding of students [3].

Misconceptions in this study are also caused by external factors, namely learning resources in the form of textbooks, teachers, and the internet. The teacher as one source of learning, providing information that is not in accordance with the right concept can cause students to misunderstand the concept. Information contained on the internet, ease of access causes students to search for information more frequently through the internet, lack of knowledge or lack of information needed to understand a concept. Misconceptions that exist in these students are likely to be caused by teachers as well as by textbooks. Misconceptions in students will be multiplied by textbook misconceptions. Textbooks that are used as the only source of information for the teacher will encourage the occurrence of misconceptions on the teacher [13], [14] also said that the cause of misconceptions in the basic concept of biology is the textbook/literature used. Biology education students also experience misconceptions on the concept of evolution caused by textbooks [15].
Beside that, misconception is caused by students’ prior knowledge or understanding. This initial knowledge or understanding comes from experience. The experience can come from the environment and from the concepts that have been obtained before. The initial concept can be from textbooks or from teachers [16]. One of the main problems in physics is the emergence of student misunderstandings that come from false initial prejudices and naive beliefs. The initial ideas that have been formed by students are very difficult to change by the teachers even though the material is presented with scientific concepts [17]. The results of the study by [18] also show that misunderstandings that cannot be eliminated are related to concepts involved in microscopic and symbolic appearance. The same was found in the [19] study that Turkish undergraduate students had a number of common misconceptions in the topic of acids and bases. Therefore, instructors should consider completing the lecture format with various active teaching / learning strategies that will encourage students to become aware of their misunderstandings.

In addition besides students who experienced misconception, also from the data it was found that there were still quite large data on students who experienced not knowing the theory. This is because these concepts are difficult to understand because they are abstract in nature and cannot be seen directly with the eyes or cannot be felt by the five senses, other things that cause students not to know the theory can come from these students as they revealed by [3] students are not accustomed to using reasoning power, but instead are accustomed to memorizing rather than understanding the concepts contained in the subject matter.

The results of the study by [5] in general, show that advanced students have learning deficiencies that are significant at the conceptual level. In order for students to have consistent and correct conceptual understanding, they must be able to develop a meaningful understanding of the concept. Likewise, with the research [20] shows that many undergraduate students do not fully understand the volcanic system and tectonic plates. The results of diagnostic tests on the concepts of cell division and reproduction show that students do not gain a satisfying understanding of cell division and reproductive concepts [21].

The research data also found that there were students who knew this theory because it was caused by several factors such as factors from within the student or external support factors. According to [22], students who master the concept can identify and work on new questions that are more varied. In addition, if the child understands a concept, he will be able to share other situations that are not used in learning situations. Experts say that learning success is influenced by many factors that come from within (internal) and from outside (external) individuals. Internal factors; internal factors include general physical conditions. While psychology includes cognitive variables including the special abilities (talents) and general abilities (intelligence). Non cognitive variables are interest, motivation, and personality variables. External factors; external factors include physical and social aspects. The physical aspect consists of the conditions of the learning place, learning facilities and equipment, subject matter and conditions of the learning environment. While the social aspects are social support and cultural influences [23].

4. Conclusion
Based on the results of the data analysis and discussion, it can be concluded as the following: In the concepts of fermentation technology, the percentage of students who were categorized as experiencing know the concepts, do not know the concepts, and misconception are 40.55%, 25%, and 34.44%, respectively. In the concepts of fermentation products, the percentage of students who were categorized as experiencing know the concepts, do not know the concepts, and misconception are 32.22%, 33.52%, and 34.26%, respectively. From the data on both concepts, it is seen that there are still quite high students experiencing misconceptions on the concept.
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