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Identification of Conceptual Understanding in Biotechnology Learning

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Abstract: Research on the identification of conceptual understanding in the learning of Biotechnology, especially on the concept of Genetic Engineering has been done. The lesson is carried out by means of discussion and presentation mediated-powerpoint media that contains learning materials with relevant images and videos. This research is a qualitative research with one-shot case study or one-group posttest-only design. Analysis of 44 students' answers show that only 22% of students understand the concept, 18% of students lack understanding of concepts, 57% of students have misconceptions, and 3% of students are error. It can be concluded that most students has misconceptions in learning the concept of Genetic Engineering.

1. Introduction

Biotechnology is a field of science that deals with techniques to manipulate the organism or its components to produce products that are useful to humans. The development of Biotechnology as a science is supported by the advancement of DNA technology. Success in making recombinant DNA provides an opportunity for the development of sophisticated techniques to analyze genes and gene expression. According to the structure of biological science, Biotechnology discusses the structure, function, and regulation at the molecular level of living things. The study of Biotechnology almost touches all groups of living things.

The rapid development of Biotechnology must be balanced with students' understanding of Biotechnology content, especially Biology teacher candidates. A good understanding of Biotechnology content along with pedagogical knowledge will be a solid provision for Biology teacher candidates to teach Biotechnology at the high school.

Genetic engineering is one of the concepts discussed in the Biotechnology curriculum. Genetic engineering can be defined as the manipulation of genetic material for practical purposes. Genetic engineering has launched a revolution in Biotechnology, thereby greatly expanding the scope of potential applications of Biotechnology [1]. The benefits of genetic engineering such as gene therapy, the creation of new vaccines, and the formation of transgenic organisms.

Learning concepts is the primary outcome of education. The concept is a mind-building stone. The concept is the internal presentation of a group of stimuli, the concept can not be observed; concepts

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must be inferred from behavior. The concept is formed according to the stimulus received by a person, so that no two people have the exact same concept. However, with different concepts that people can communicate by using the names given to concepts that have been accepted together. The concept is the basis for higher mental processes to formulate the principles and generalizations [2]. The correct of conceptual understanding is an important result of cognitive outcome in science. The classical approach to knowledge acquisition and conceptual change assert that science learning to take place over a very short period of time [3]. However, according to [4] a newer approach suggests that the correct of conceptual understanding involves a lengthy process. Through this long period of time, learners will interact with new information in a socio-cultural context that enriches the conceptual understanding or restructuring existing conceptual understanding.

According to Flavell in [2] a concept has been learned when the learner can display certain behaviors. Klausmeier in [2] state there are four levels of conceptual achievement, namely concrete level, identity level, classification level, and formal level. Information about concepts that must be taught to learners of a certain age or class may be derived from a number of sources, including textbook writers, curriculum developers, educators' knowledge and experience, and learners themselves. After selecting the concepts to be taught, the educator should plan the learning strategy to teach the concepts. To that end, an educator not only master the knowledge of the field of study to be taught, but also various approaches and methods of learning and various learning theories to guide educators in applying the approach and method chosen [2].

This study aims to identify the conceptual understanding in biotechnology learning, especially on the topic of Genetic Engineering.

2. Method

This research is a qualitative or pre-experiment research with one-shot case study or one-group posttest-only design, i.e. treatment is only given to one group of subjects. Observations were made on group members to determine or assess the effect of treatment (Asher and Vockell in [5]).

Biotechnology learning is conducted by means of discussion of media-aided image and video. Data collection was conducted in December 2015 with test techniques. The test consists of six true-false-level objectives question about the concept of Genetic Engineering. The question modified from Biology book [1]. Each student was asked the reason for each question he answered and his belief in the answer given. The test was followed by 44 students of Biology Education Program, Faculty of Teacher Training and Education, Islamic University of Riau who have taken Biotechnology course. Students' answers are examined one by one and analyzed qualitatively in accordance with the provisions of [6] below:

Table 1. Categorization for respondents' answers.

Category	Answer type
1. Understanding the Concept	The answer is right, the reason is right, sure
2. Lack of understanding of the concept	The answer is right, the reason is right, not sure The answer is wrong, the reason is right, not sure The answer is right, the reason is wrong, not sure The answer is wrong, the reason is wrong, not sure
3. Error	The answer is wrong, the reason is right, sure
4. Misconception	The answer is right, the reason is wrong, sure The answer is wrong, the reason is wrong, sure

3. Results and Discussion

An examination of the test answers of 44 respondents was presented in Table 2 below:

Table 2. The analysis of respondents' answers.

Question Number	Number of answers (people)		Number of reasons (people)		Level of confidence (people)	
	Correct	Incorrect	Correct	Incorrect	Sure	Not Sure
1	19	25	20	24	40	4
2	40	4	10	34	35	9
3	14	30	10	34	30	14
4	41	3	15	29	35	9
5	39	5	9	35	38	6
6	42	2	9	35	38	6
Average					82%	18%

Based on the data in Table 2, the number of students who answered correctly is always more than the incorrect answer, except for questions number 1 and 3. With regard to question number 1, students are not expected to understand well about the types of enzymes used in genetic engineering and its function. Furthermore, students should understand the structure of plant cells and animal cells well in order to answer the number 3 correctly.

If it is related to the reasons given by the student for each question, the overall correct reason is always smaller than the number of correct answers. That is, the students have the big opportunity to guess the answer because the tested question is a matter of objectively true-false. However, this objective limitation is overcome by asking students to state the reasons for the answers they provide. This can differentiate between students who really understand the concept with students who guess answers. However, for question number 1 there is one student (respondent number 27) who is wrong in answering the question, but the reason given is true. Allegedly the student may be penalized in writing the answer, when he understood the question well.

The level of student confidence in answering the overall question and the reason given the high average is 82%.

Furthermore, the overall test results were grouped into four categories according to [6]. The results can be seen in Table 3 below:

Table 3. Categorization of respondents' answers.

Question Number	Category				Total
	Understand the concept (%)	Lack of understanding the concept (%)	*Error* (%)	Misconceptios (%)	
1	16 (36)	4 (9)	2 (5)	22 (50)	44
2	8 (18)	9 (20)	1 (2)	26 (59)	44
3	5 (11)	14 (32)	3 (7)	22 (50)	44
4	11 (25)	9 (20)	1 (2)	23 (52)	44
5	9 (20)	6 (14)	0	29 (66)	44
6	8 (18)	6 (14)	1 (2)	29 (66)	44
Total	57 (22)	48 (18)	8 (3)	151 (57)	264

Table 3 illustrates the number of students who 'understand the concept' more than any other category (lack of understanding of concepts, errors, and misconceptions) only on question number 1. In addition, for question number 2-6 the number of students 'misconception' is always more than other categories (understanding concepts, lack of understanding of concepts, and errors). Overall, the error category always exists in small numbers, except for question number 5, there is no error.

The focus of this research is to identify the conceptual understanding in learning the concept of Genetic Engineering. Based on the analysis of the data obtained can be stated that most students have misconceptions in the concept of Genetic Engineering. [7] states that misconceptions represent an interpretation of concepts that are not accepted by the learner. According to [8] misconceptions are also known as 'alternative conceptions', 'naive beliefs', 'children's ideas', 'conceptual difficulties', 'phenomenological primitives', 'mental models' , etc. According to [9], misconception is a perception of phenomena occurring in the real world that is inconsistent with the scientific explanation of the phenomenon. Misconceptions may vary from minor misconceptions to rejection of complex theories that can be fundamental barriers to students' understanding of scientific explanations.

To overcome misconceptions, [7] suggests that learners should be able to generate a logical connection between evidence and alternative conceptions. In this case, the method of discussion conducted in learning is expected to explore students' insights about the facts of genetic engineering that can be obtained from various sources of learning. In addition, in the implementation of learning is also equipped with a powerpoint and video presentation to clarify things complicated. According to Suryosubroto in [10], the method of discussion is a way of presenting teaching materials with educators providing opportunities for learners or groups of learners to hold scientific conversations to collect opinions, draw conclusions, or arrange alternative solutions to problems.

Discussion methods used in Genetic Engineering learning can not be said to be ineffective and as a cause of misconceptions in most students, as there are no other student groups as a comparison. Although discussion methods have limitations such as discussion of issues often out of context, and information obtained by students is limited [10, 11] in his study suggests that learners better assimilate ideas about genomes and genetic engineering in the field of medicine during discussion, and association of information in the mass media with discussion activities can help to disseminate scientific concepts. Meanwhile, [12] in their study stated that Genetic Engineering learning in laboratory outreach can increase substantial knowledge both in short and long periods, and motivated learners achieve higher scores.

The average level of confidence in answering the whole question is high i.e 82%, while the respondent students who understand the concept is only 22%. This is different from the opinions of [13] that students who master the concept well will have a high confidence. That is, only students who answer the question correctly, and provide the correct reasons alone who have great confidence because of his high confidence. But according to the categorization by [6], students who have confidence include students who 'understand the concept', students who experience 'misconception', and even students who 'error'. Only students who 'lack of understanding the concept' are not sure of the answers and reasons given.

4. Conclusions

Based on the results of research and discussion, it can be concluded that most students indicating misconceptions in the Genetic Engineering concept. It is advisable for educators to seek alternative learning methods that connecting the concept of Genetic Engineering to real life situations. Interviews or surveys should also be conducted to determine the causes of students' misconceptions, and need to design valid and reliable diagnostic tests to analyze student conceptions in genetic engineering learning.

References

[1]. Campbell, N.A., Reece, J.B., Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V., and Jackson, R.B. (2010). *Biologi* (terjemahan). Jakarta: Erlangga
[2]. Dahar, R.W. (2011). *Teori-teori Belajar & Pembelajaran*. Jakarta: Erlangga
[3]. Renken, M. D., dan Nunez, N. (2013). Computer simulation and clear observations do not guarantee conceptual understanding. *Learning and Instruction, 23*: 10-23
[4]. Vosniadou, S. (2007). The cognitive-situative divide and the problem of conceptual change. *Educational Psychologist, 42*(1): 55-66

[5]. Setyosari, P. (2013). *Metode Penelitian Pendidikan & Pengembangan.* Edisi Ketiga. Jakarta: Kencana Prenada Media Group.
[6]. Kaltakci, D. & Didis, D. (2007). Identification of pre-service physics teachers' misconceptions on gravity concept: A study with a 3-tier misconception test. Dalam S. A. Cetin, dan I. Hikmet (Eds), *Proceedings of the American Institute of Physics*, USA, 899, 499-500
[7]. Svandova, K. (2014). Secondary school students' misconceptions about photosynthesis and plant respiration: preliminary results. *Eurasia Journal of Mathematics, Science & Technology Education, 10*(1): 59-67
[8]. Gurel, D. K., Eryilmaz, A., dan McDermott, L. C. (2015). A review and comparison of diagnostic instruments to identify students' misconceptions in science. *Eurasia Journal of Mathematics, Science & Technology Education, 11*(5), 989-1008
[9]. Yates, T. B. dan Marek, E. A. (2014). Teachers teaching misconceptions: A study of factors contributing to high school biology students' acquisition of biological evolution-related misconceptions. *Education and Outreach, 7*:7.
[10]. Putra, S. R. (2013). *Desain Belajar Mengajar Kreatif Berbasis Sains*. Jogjakarta: DIVA Press.
[11]. Freire, A. S., Xavier, M. C. F., dan Moraes, M. O. (2013). High school students' attitudes associated with biotechnology and molecular genetics concepts in Brazil. *Creative Education, 4*(2): 149-153
[12]. Goldschmidt, M., dan Bogner, F. X. (2015). Learning about genetic engineering in an outreach laboratory: Influence of motivation and gender on students' cognitive achievement. *International Journal of Science Education, Part B: Communication and Public Engagement*. http://dx.doi.org/10.1080/21548455.2015.1031293
[13]. Kurbanoglu, N. I., dan Akin, A. (2010). The relationship between university students' chemistry laboratory anxiety, attitudes and self-efficiency beliefs. *Australian Journal of Teacher Education, 35*(18), 48-59