Preconception analysis of evolution on pre-service biology teachers using certainty of response index

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Abstract. Preconception of students about evolution often related to knowledge got from environment and resource surrounding without scientific base. Therefore, it was needed badly to detect misconception on students before the courses so as to determine the direction to overcome it. This qualitatively descriptive study was conducted to get clear picture of student conception in evolution before the course held. And also the probability of misconception. A number of students from Islamic University in Cirebon was involved as participants (n=54). The instrument used consisted of 10 multiple choice with certainty of response index (CRI) and individual interview to analyze the reasons or the causes of misconception. Research results show that the percentages of understand concept (UC), not understand concept (NUC), guessing (G) and misconception (M). It was also found that the percentage of misconception among the students is relatively high (35.7%) from the whole answers given to the test items tested. The highest misconception detected was in Phylogenetic topic. Based on the individual interview it was detected that they have difficulties in certain concepts in sequent: phylogenetic (50%); the origin of living things (24%), natural selection (3.7%) and evolutionary theory (16.6%).

1. Introduction

Concept is an idea or representation of the constituent parts or common attributes by which groups or classes can be distinguished [1]. Fraser states that any knowledge that a learner possesses before learning begins is a prior knowledge. While the knowledge possessed after the learning is called mastery of the concept [2]. States that concepts are abstractions based on experience, therefore no one has the same experience [3]. The concept as a group of objects or events or symbols, real objects that have the same characteristics and identification results with the same name [4].

Learning process involves social interaction between educators and learners. The intended interaction is the process of transforming knowledge from educators to learners. There are many obstacles that sometimes cause the process of understanding science provided by educators to be misunderstood or misinterpreted by learners who receive it. Before entering college, some learners already have the prior knowledge that is embedded in their mind. This may be true or otherwise the wrong understanding of a concept. Inaccurate understanding of concepts that students understand before or after learning are interpreted as misconceptions.

Recent research results found that educators also experienced misconceptions similar to the learners [5]. States that teachers sometimes do not understand the material as a whole or have difficulty translating concretely of abstract concept material because of lack of understanding on the previous...
education level [6]. Other studies have found that there are teachers who deliberately eliminate certain materials and do not teach them in class for a cause [7]. Misconception is interpreted as a cognitive structure that is rooted in students' thinking but deviates from the conception described by experts in their field. Educated learners will replace their misconceptions with the correct concept if they meet the four criteria, that is unsatisfied with the understanding they have, and new concepts are intelligible, plausible, and fruitful [8].

This research the students' pre-conception especially on evolutionary topic. Because of scientists argue about complex evolutionary situations [9]. The target is a biology education student who has not yet studied evolutionary material. This is done to determine the pre-conception of students before attending evolution course. When the initial pre-conception is obtained, it is likely to recognize the possibility of misconception early in the lecture. Evolution is a compulsory subject for pre-service biology teacher. Therefore, although it is not burdened with many credits, but evolution has a position as a subject that is considered important. This is mandated by Biological Consortium standards as part of the courses that must be taught in biology education and pure biology department at level 6 [10].

Certainty of Response Index (CRI), proposed by Hasan & Kelley is a method used to identify the degree of misconception on a concept [11]. This method can also separate between the criteria of Understands the concept and Doesn’t Understand the concept based on the answers given. The response given will prove whether a concept is really understood or it is known through memorizing only [12]. In general, difficulties in understanding the material of evolution are usually seen from the tendency of the results of answers that are based on environmental factors [13].

2. Method
Descriptive qualitative research (is a qualitative descriptive research whose purpose is) to provide knowledge about misconception experienced by prospective biology teacher in evolution course by using Certainty of Response Index (CRI). In this study, researchers did not treat or manipulate data, but researchers only provide a detailed picture of the state of pre-concept of students and possible misconceptions that have occurred early in the recovery before the learning process takes place. Qualitative research is a research that intends to understand the phenomenon that occurs on the subject of research such as behavior, views, motivation, actions, etc., holistically, and by way of description in the form of words and language, in a special context that is natural and by utilizing various natural methods [14]. This research was conducted at one Islamic college, in Cirebon, West Java. The data were collect from tests given to 54 Biology education students who are spread into 2 classes. Students chosen as the subjects have followed the prerequisite courses for evolution lectures are genetic courses.

3. Result and Discussion
Results obtained in the study can be seen in Table 1.

| No. | UC | %   | NUC | %   | M | %   | G | %   |
|-----|----|-----|-----|-----|---|-----|---|-----|
| 1   | 11 | 20.3%| 16  | 29.6%| 23 | 42.5%| 4 | 7.4% |
| 2   | 12 | 22.2%| 15  | 27.7%| 23 | 42.5%| 4 | 7.4% |
| 3   | 11 | 20.3%| 17  | 31.4%| 18 | 33.3%| 8 | 14.8%|
| 4   | 15 | 27.7%| 12  | 22.2%| 20 | 37.0%| 7 | 12.9%|
| 5   | 8  | 14.8%| 18  | 33.3%| 22 | 40.7%| 6 | 11.1%|
| 6   | 23 | 42.5%| 12  | 22.2%| 8  | 14.8%| 11| 20.3%|
| 7   | 0  | 0%   | 16  | 29.6%| 32 | 59.2%| 6 | 11.1%|
| 8   | 23 | 42.5%| 7   | 12.9%| 15 | 27.7%| 9 | 16.6%|
| 9   | 15 | 27.7%| 16  | 29.6%| 15 | 27.7%| 8 | 14.8%|
| 10  | 17 | 31.4%| 13  | 24.0%| 17 | 31.4%| 7 | 12.9%|
| Total| 135| 25%  | 142 | 26.2%| 193| 35.7%| 70| 12.9%|
The answer given by the students majoring in biology education on the given problem is very diverse. Students' conceptions analyzed based on the Certainty of Response Index are as follows, Understands the Concept category of 25%, Not Understand the Concept category of 26.2%. Guessing category is 12.9% while Misconception category is 35.7%. Based on the data in Table 1, the total number of students who guessed the lowest number, is on the question number one and number two, which are four students about the material Lamarck's theory of evolution, and relationship of Mendel and theory of evolution. While the question is the most high number of students who answer by guessing is on question number 6 that is a number of eleven students on the subtopic Use of Hardy-Weinberg law.

The student's preconception description on all the measured topics can be shown in Figure 1. It is generally illustrated that each topic indicates that there are always students who have misconceptions. Based on the percentage of data obtained, the highest number of students in the Understands the Concepts category is in the question numbers 6 and 8, Not Understands the Concept at number 5, Guessing the most is at answer number 8. The highest Misconception is on item 7 regarding the subtopic phylogenetic. The lowest Misconception category is on the numbers 8 and 9 in the subtopic of geographic isolation and vertebrate evolution of 15% of students experiencing misconceptions on both of these questions.

![Pre-concept of All Subtopics](image)

**Figure 1.** Student Conception Diagram

While the misconception category of each student is shown in Figure 2. In this study, it was found that in each question given, there were students who experienced misconception. The highest misconception was experienced by a student with the code M.23 with nearly all of what had been learned 90%, so the majority of the answers given by M.23 students has a misconception. While students who do not experience misconception at all are four people, namely students with the code M.25, M.29, M.45, and M.46. However, students who do not experience misconceptions do not indicate that they understand the concept, this is because it is found that students who do not understand the concept tends to guess.
Figure 2. Percentage Misconception Diagram of each Student

The misconceptions experienced by students related to the topic of the lecture can be seen in Figure 3. Students experiencing misconceptions on evolution lecture materials, based on the data obtained, the lowest is 8 students in question number 6 which is on the subtopic use of Hardy-Weinberg Law, while the highest score or at most answers given indicating misconception is the answer to question number 7, which are 32 students or 59.2%. The topic discussed in question number 7 is the question of Phylogenetic.

Figure 3. Misconception of Student According to Topics

The recapitulation of interviews on the analysis of the causes of student misconceptions on the theory of evolution in the interest aspect can be seen in Table 2. It is found that 57% of the students did not like the evolution material, 70.3% of the students stated that they had difficulties in understanding the evolution material, and only 46.2% accepted evolution as the cause of the diversity of living things indicates that still more than 50% of the students given the test, do not accept the theory of evolution.

Table 2. Recapitulation of Student Interview Result on Interest Aspect

| Questions                                                                 | Responses |
|--------------------------------------------------------------------------|-----------|
| Evolution is a material you like.                                        | YES 31    | NO 23     |
| Evolution can be easily understood                                      | YES 16    | NO 38     |
| Receive Evolution as the cause of the diversity of living things        | YES 25    | NO 29     |
The results of interviews on students on the aspects of learning can be seen in Table 3. Although evolution has not been taught, and evolution is a matter of controversy, but most students have a source of learning about evolution, even as many as 53 students claimed to have studied evolution material even though this course have not been studied formally in class.

**Table 3. Recapitulation of Interview Results on Aspects of Learning**

| Misconception Causes                     | Responses |
|------------------------------------------|-----------|
| Do you have a source about evolution     | YES 35 NO 21 |
| Have you ever learned about evolution    | YES 53 NO 1 |
| Did the lecturer explain about the evolution to the students | YES 53 NO 1 |

In Table 4, we can see the results of the interview on the aspect of acceptance or rejection of the theory of evolution. The strongest reason behind the rejection is because it is contradictory to their belief (nearly 27). While the reason for the highest acceptance is because students have seen and believe in evolution based on existing scientific evidence. Abraham's research finds that evolution is a matter of controversy [15].

**Table 4. Recapitulation of Interview Results on Aspects of Reasons for Acceptance / Rejection**

| Misconception Causes                           | Total |
|------------------------------------------------|-------|
| Belief                                         | 15    |
| The difficulty of materials to be understood   | 14    |
| Accepting by scientific facts / evidence       | 14    |
| Controversy                                    | 1     |
| Accepting for interests / interesting material | 9     |

Recapitulation of student interview result on subject of evolution aspect that is considered difficult can be seen in Table 5. The evolutionary material which is considered most difficult to study is phylogenetic material. A total of 27 out of 54 students or 50% of students consider phylogenetic material is difficult to study. In addition, students also thinks that the material of the origin of living things and the theory of evolution as a difficult material.

**Table 5. Recapitulation of Interview Result on Aspect of Material Considered as Difficult**

| NO | Difficult Materials | Totally |
|----|---------------------|---------|
| 1  | Evolution Theory    | 9       |
| 2  | The origins of living things | 13     |
| 3  | Natural Selection   | 2       |
| 4  | Phylogenetics       | 27      |
| 5  | No difficult materials | 3     |

Table 6 illustrates the recapitulation of interviews with students on the early knowledge aspects of evolution. The findings in this study indicate the same thing with some previous research. The study found that 45 out of 54 students or 83.3% received prior information about the lies of the theory of evolution. This coupled with evolution is a theory that contradicts the beliefs held by students.
Table 6. Recapitulation of Interview Results on Aspects of Prior Knowledge of Evolution

| NO | Information Acquired                        | YES | Totally |
|----|--------------------------------------------|-----|---------|
| 1  | Evolution is a lie                          | 45  | 9       |
| 2  | The theory of evolution contradicts beliefs | 47  | 7       |

4. Conclusion
Results reveal the number of students who Understands the Concept, Doesn't Understand the Concept, Guessing, and Misconception. It was found that not all students has/on a misconception, but the percentage of students experiencing misconceptions is also quite high, namely 35.7% of the overall answers on all test items tested.

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