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Identifying the Misconceptions in Students' Biology Department on Genetics Concept with CRI Method

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Abstract: This study aimed to determine the level understanding of students, who experience the misconceptions, know the concept and do not know the concept of genetics; sub concepts which often become a misconception and the factors that cause the occurrence of misconceptions. This study used CRI method (Certainty of Response Index) to identify the students' misconceptions. The population in this study are the Biology Department. The sample as the subjects in this research are the Biology Department students of Makassar State University period 2011 with 91 total numbers consisting of two classes; class ICP (International Class Program) and class A educational study program. The instrument used was diagnostic tests in form of reasoned multiple choice equipped with CRI value and a structured interview to find out the cause of the misconceptions. The findings showed that there was a misconception on eight sub concepts which was observed by the percentage experiencing misconceptions, understanding the concept and not understanding the concept in succession 45.8, 28.2 and 26%. The highest percentage of the students experiencing misconceptions contained in the sub concepts of Mendel inheritance 60.2%, sub concepts of protein synthesis 59% and sub concepts of mutation 55%. Factors becoming the cause of misconceptions were the wrong understanding to the concept, the incompleteness information received from the students, the wrong experiences and observations of the students, the terms and concepts that have been so long, learning experience at school and errors in the textbooks.

Key words: Misconceptions, CRI (Certainty of Response Index), the concept of genetics, ICP (International Class Program), learning experience

INTRODUCTION

Before attendingthe biology instructional practice formally at school or at college, students and university students have brought the initial concept of biology itself. The initial concept that they brought is sometimes inappropriate or contrary to the concept accepted by the experts. Those different concepts are often called misconceptions or alternative concepts. They have got those initial concepts when they were still in elementary school, middle school and from their experiences and observations in the community or in daily life.

According to Tekkaya (2002) in biology, misconception is commonly found among the concepts related to respiration, photosynthesis, ecology, energy flow, genetics, classifications and circulation system. Students' misconception in science education has become a focus point for the researchers in recent years.

Recent studies have revealed that students had difficulty in understanding the science subjects and the difficulty of the students in these subjects created a significant obstacle to learn the next level (Bahar, 2003).

Misconception is also attacked by all levels of students, starting from elementary school to the university students. Indeed, from several studies, misconception is also prevalent to the teachers (Nadelson, 2009; Cokadar, 2012). Menurut Widha, research findings from various countries showed that misconceptions experienced by the students due to the lack of proper application and the use of media that cannot illustrate the concepts studied. Another opinion explained that misconception is affected by the process of the formation of knowledge in the minds of the students. There are also misconceptions in biology textbooks. As the consequence, both teachers and students who use thos etextbooks will have misconceptions.

One of the topics in biological field which become the research materials among educators is the difficulty of the students to understand the concept of genetics as well as the misconceptions on the connected materials.

Research has shown that there are some misconceptions and learning difficulties on the concept of genetics among middle school students, undergraduate and post-graduate students.

It also showed that the learners have problems with the concept and in explaining inheritance in molecular level. In this sense, genetics is considered as a complicated subject and full with abstract conceptual relationship.

Duncan and Reiser (2007) asked a question "Why does the study of genetics become a difficult phenomenon for the learners?" There are two answers to this question. The 1st, the students have difficulty because geneticsis an abstractmaterial and students cannot connect the concepts obtained. The second, geneticsis included as a complicated structure. Genetics involves some biological organizationsin the level of genes, proteins, cells, tissues, organs and others. Therefore, misconceptions on the concept of genetics must be identified and addressed as it can cause destructive effects on the next subsequent academic.

There are some ways that can be used to identify misconceptions. One of them is the presentation of a concept map, multiple choice test with open grounds, making of scientific papers, using assessment concept and CRI with a structured interview.

CRI can be used to identify misconceptions once can distinguish the people who does not know the concept (Hasan *et al*., 1999). CRI is a measurement of the level of confidence or assurance respondents in answering any questions (task) given. CRI is usually based on a scale given in the same time with each answer for each question. CRI uses a scale of 6 (0-5).

According to Tayubi (2005), rate 0 indicates no idea of the concept at all (totally predictable answers) while rate 5 signifies the full confidence of the correctness of knowledge in answering a question (task) and there is no guessing at all. If the degree of certainty is low (CRI 0-2), then it describesthe guessing process plays a significant role in determining the answers.

Without considering whether the answer is right or wrong, a low CRI valueindicatesthat there is a guessing which indirectly reflect the ignorance of the concept underlying the determination of the answer. If the CRI value is high (CRI 3-5) it means that the respondents have a high confidence in choosing an answer. In this state (CRI 3-5) if the respondent answers correctly, this could indicate that a high level of confidence to the truth of its biological conception could have been well tested.

However, if the answers obtained is incorrect, it shows the existence of a misconception in knowledge about a subject matterowned and it can be an indicator of occurring misconceptions. There are four possible combinations of the answers (correct or incorrect) and CRI (high or low) for each respondent individually. Low CRI (<2.5) with right or wrong answer indicates the respondents' criteria with do not know the concept. Meanwhile, a high CRI (>2.5) with the correct answer shows the respondents with criteria of mastering the concepts well. As if the answer is wrong with high CRI values (>2.5) it shows the respondents with experiencing misconceptions criteria.

On the concept of genetics, there are 8 subconcepts becoming the research materials, including the terms related to the mechanisms of inheritance, the scope of genes, heredity of tonsil, the relationship of cell division by inheritance, mutations, protein synthesis, chromosome scope and determination of the sex.

The identification of misconceptions on the concept of genetics needs to be done in order to know the wrong concept to the students and their causes. Based on the problems described it is necessary to research that aimed to determine the level of students' understanding of the concepts of genetics, subconcept which is commonly misconceptions and the factors that cause those misconceptions.

MATERIALS AND METHODS

This research is a descriptive study. The population in this study are biology students of Makassar State University. The sample as the subjects in this research are the Biology Department students of Makassar State University period 2011 with 91 total numbers consisting of two classes; class ICP (International Class Program) and class A educational study program. The selection of research subjects was done by "purposive sampling".

Data collection techniques in this study was by using diagnostic tests and interviews. Diagnostic test was in the form of reasoned multiple choice tests. Each question answered from the students was recommended to fill the confidence level (CRI) in the form of a scale from 0-5 for each answer of the question and gave reasons about that answer. The interviews were conducted to the subjects experiencing misconceptions by using interview guideline. The purpose of the interview was to find out the cause of the misconception occurring in students.

Related to diagnostic tests that have been made, the validity of the two validators' expertsin genetics and evaluation was tested. Then, piloting has been done to know the validity, reliability, the level of difficulty and the distinguishing power. Then, CRI was analyzed to distinguish students who know the concept, do not know the concept and who have misconceptions with the criteria stated by Hasan *et al.* (1999) (Table 1).

Table 1: Criteria to distinguish between know the concept, misconceptions and do not know the concept individually (Hasan *et al*., 1999)

Answer criteria	Low CRI (<2.5)	High CRI (>2.5)
Correct Answer	Correct answer but low CRI means do not know the concepts	Correct answer and high CRI means know the concepts
Wrong Answer	Wrong answer and low CRI means do not know the concepts	Wrong answer and high CRI means have a misconception

After calculating the percentage for each criterion of the students who have misconceptions, know the concept and do not know the concept, the amount of each criterion was dividedby the total students. The research data were analyzed descriptively by using the technique of presentation.

RESULTS AND DISCUSSION

Students' concept comprehension on the concept of genetics: The results of data analysis-based diagnostic tests with CRI shows that the average percentage of students who have misconceptions is still higher than the percentage of students who understand the concept which is amounted to 45.8%. The percentage of students who understand the concept is 28.2%. It is still more than the students who do not understand the concept, as big as 26.0%.

The high number of the students who have misconceptions is mostly caused by the wrong understanding of the students to the concepts of genetics. The wrong understanding of the students is because of the incompleteness of the information received from their own learning experiences and from their peers. Students who are actively looking for the information will construct their own knowledge well. While the students who are passive will lead to the interrupted knowledge which is constructed in the minds of the students. The experience of students studying genetics at school also has a big influence on the misconceptions that occurs. It is based on the results of the interviews from the students who connect misconceptions with the concept accepted by their teachers at school. The initial erroneous concept is still carried by the students to the university level. Preceding preconception or early conception can be a trigger as the appearance of misconceptions.

Students' understanding to the sub-concepts of genetics: Students' understanding of the eight subconcepts tested can be seen in Fig. 1.

Figure 1 shows that misconceptions occurred on eightsub concepts tested through diagnostic test with CRI method. The first highest misconception was in the third sub concepts, namely sub conceptsof tonsil inheritance amounted to 60.2%. The second highest misconceptions was in the 6th sub concepts, namely conceptsof protein synthesis by 59% and the 3rd highest misconceptions is in the fifth sub concepts, namely sub concepts mutation of 55%.

The high students' misconceptions in the third sub conceptswas caused by some factors including; the wrong understanding of the students to the material of tonsil inheritance. The incorrect understanding occurred in the material of Mendel Law 1 and 2 which were conceived separately and differently by the students, even though both are interconnected. The incorrect comprehensionis caused by the incompleteness information received from the textbook used by the students. Mendel Law 1 is always associated with dihybrid so is Mendel Law 2 with dihybrid cross.

According to Tekkaya (2002), the incompleteness information received by the students caused by the students themselves became one of the causes of misconceptions. The incorrect understanding also happened to theresult determination of crosses Mendel which is misinterpreted as a''number of offspring' that is produced not as a "possibility". School learning experiences may also lead to themisconceptions on the third sub concepts. Based on the interviews from the teacher, it was explained that Mendel Law 1 happened earlier than Mendel Law 2 and they were described separately. Stenrberg stated that the teachers at school were one of the causes of misconceptions which greatly affects the conception of the next students.

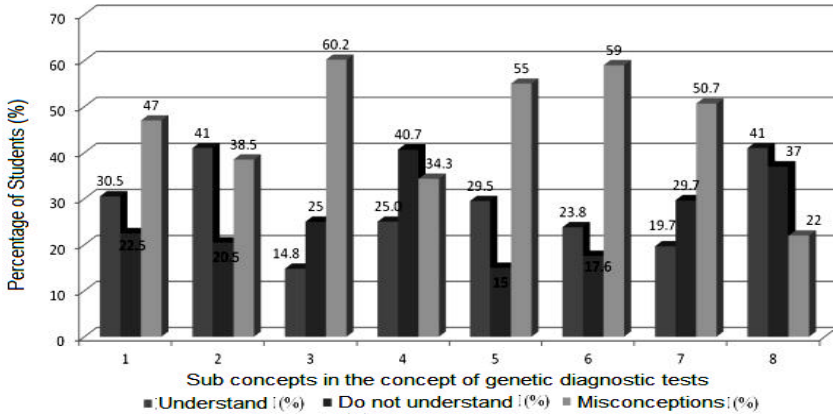

Fig. 1: The level of the students' understanding for each sub concept-based diagnostic test results on genetics concepts

At the 6th sub concepts, the cause of misconceptions was due to the incorrect understanding by the students toward the products of transcription and translation. That incorrect reasoning was caused by the very strong word association between one term and other terms. For instance, the amino acid is always associated with the word "protein". Suparno, stated the role of word association in cognitive errors has proved as very difficult to replace the old information. The incompleteness information received was also the cause of misconceptions, such as the material products of the transcript which was understood by the studentsonly produce mRNA molecules neither tRNA nor rRNA.

At the 5th sub concepts the cause of misconceptions occurred because of the wrong experience and observation to the mutation phenomenon. The students misinterpreted the concept of mutation. It caused the students' understanding to the task given was also wrong. Students assumed that mutations always give effect to changes in the phenotype of living beings. That changes make the damage to the phenotype of living things such as disability or illness.

Factors causing misconceptions: The results of students' interviews showed that there were several factors that caused misconceptions on the concept of genetics, among others was students' incorrect understanding. The incorrect understanding wascaused by the information received by the students was incomplete as a result of passive learning experience in finding information. Based on the subsequent interviews, the students assumed that the genetics material is an interesting material but it has a lot of complicated terms and an abstract processes as in sub concepts protein synthesis.

Other causes of misconceptions was because of the terms and concepts that have long been obtained by the students from the learning experience at school, as the term for genotype and phenotype. As stated by Hershey that the terms and concepts that have been so long and maintained by the students can be the cause of misconceptions. In studying the genetics, the studentsfelt difficult establishing a relationship between one material andthe others. Such as between cell division with Mendel Laws 1 and 2 and the relationship between genetics of Mendel at the molecular level. This is in line with the research findings conducted by Dikmenli *et al*. (2011) that there were alternative conceptions or misconceptions of the genes, DNA and chromosomes to the students once as candidate teachers. The students also have difficulty in connecting genetics materials that have been studied in advance at the molecular level.

CONCLUSION

Data from analysis testing showed that the level of students' understanding on the concept of genetics was still more likely to have misconceptionsthat is equal to 45.8%. While the students who understood the concept and did not understand the concept respectively 28.2 and 26%. The percentage of the students experiencing misconceptions occurred in all sub concepts tested. Sub concepts of Mendel heredity experienced misconceptions was 60.2%, then sub concepts of protein synthesis and mutation were respectively 59 and 55%.

The factors causingmisconception was the wrong understanding, the incompleteness information received by the students, the terms of genetics that have so long, the very strong word associations, the learning experience at school and errors in textbooks.

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