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Identification of senior high school student's misconceptions in makassar city on cell concepts by using the certainty of response index (CRI) method

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Abstract. This study aims (i) to determine the level of understanding of high school students on the concept of cells (ii) to identify which basic competencies of the concept of cell students who experience misconceptions. This research is descriptive research. The method used to identify misconceptions that occur in students is the Certainty of Response Index (CRI). The sample in this study were students from 8 senior high schools in the city of Makassar. The instrument used in the form of a reasoned multiple choice diagnostic test equipped with CRI values and structured interviews to determine the causes of misconceptions. The results showed that high school students in the city of Makassar experienced misconceptions on the 6 Basic Competencies about the concept of cells which were studied with the tendency of students to experience more misconceptions in Basic Competence 3.2 to compare transport mechanisms in membranes (diffusion, osmosis, active transport, endocytosis, and exocytosis) from observations and Basic Competence 4.2 experiment with diffusion and osmosis by using potato tubers or spinach or salted stem and linking them to trans membrane transport events

1. Introduction

The Biological Challenge of the 21st century requires students to integrate concepts at the organizational level to a more complex level in the learning process in the classroom[1]. so that this knowledge should be well understood.

The concept is used as a basis for thinking to solve problems in the learning process. Sometimes concepts that are deviated even conflict with existing scientific concepts. This results in barriers to the acceptance of new concepts that will be studied, understanding concepts that are different from the scientifically accepted concept is known as misconception [2]. Misconceptions are also referred to as erroneous ideas [3]. If this condition occurs, it should immediately be overcome because misconceptions are also factors that influence learning. Misconception can be obtained before entering school or can be triggered in the formal stage of education that is being undertaken.

In the field of biology, many studies have reported misconceptions on several concepts including the concepts of vertebrates and invertebrates [4], the concept of cell structure and function [5], the concept of photosynthesis [6], the concept of transportation systems and excretion systems [7], the concept of diffusion and osmosis [8], the concept of genetics [5], the concept of protein synthesis [3],[5], on the concept of evolution [5] and misconceptions on the concept of cell metabolism [9].All



the biological concepts mentioned are closely related to the concept of cells in general. If the concept of cell occurs misconception then it is certain that misconception will develop in other material, considering the concept of cells is basic and very closely related to other material in biology. Misconceptions on basic concepts will lead to difficulties in connecting one concept to another.

In addition to misconceptions derived from textbooks, misconceptions possessed by students can be obtained from the results of the learning process in the classroom, in other words can be sourced from the teacher. It has also been shown that teachers can play a role in the formation of misunderstandings held by their students [10][11]. Furthermore argues that, assessment strategies used by biology teachers can be factors that influence the development of misunderstandings[10]. on their students. Teachers can be a source of many misconceptions held by students [12]. Furthermore, with the results which explains that if the teacher is wrong in understanding and giving an explanation of the concept in the learning process, then students will also accept the wrong concept[13]. Furthermore reported that there were misconceptions in high school teachers in the city of Makassar Indonesia, as many as 48, 30% experienced misconceptions, 49.10% who understood the concept, and only 10.77 % who do not understand the concept [14]. Most likely misconceptions also occur in students.

One way that can be used to find out whether someone is experiencing misconceptions or not is to use the Certainty of Response Index (CRI) method. CRI is a diagnostic test in the form of multiple choice questions with a combination of the level of correctness of the selected answers [15].

2. Method

This research is a descriptive study that describes the misconception of the concept of high school students in the city of Makassar. This research was carried out in the State High School in the city of Makassar from April 2018 to November 2018. As for the subject in this study were Makassar city high school students who had learned cell concepts.

The population in this study were all high school students in class XI in high school in the city of Makassar. As for the sample (subject) of this study are students of class XI in high school who have learned the concept of cells. The selection of research subjects was done by purposive sampling technique. Aiming because the student sample was obtained from school data that had previously been known that there was a misconception on the biology teacher from 8 high schools in the city of Makassar.

This study uses research instruments in the form of reasoned multiple choice tests to determine students' misconceptions and interview guidelines to obtain supporting data on misconceptions that occur in state high school students in the city of Makassar. Data collection techniques used in this study are interview techniques (non-test) using interview guidelines and measurement techniques (tests) using diagnostic test instruments in the form of reasoned multiple choice tests. Students are asked to fill in the level of confidence in the form of a scale of 0 to 5 on the answers given to the questions posed on the questions and give reasons for the answers. Interviews are aimed at obtaining supporting data on misconceptions that occur in high school students in Makassar City. The test instrument that has been made, tested the validity with two expert validators in the field of cell biology and evaluation. The instrument is then tested on a different sample and each item is analyzed with the ANATES V4 program to determine the value of validity, reliability, differentiation and level of difficulty. Data analysis techniques to identify misconceptions, know the concept and do not know the concept using the CRI (Certainty of Response Index) method.

3. Result

3.1. Reserach Result

The results of data analysis on the level of understanding of high school students in Makassar City on the concept of cells using the CRI method can be seen in Figure 3.1. Based on Figure 3.1 it can be seen that there are 18.22% of students in Makassar City who understand the concept of cells, 49.80%

who do not understand the concept of cells, and 31.98% who experience misconceptions in the concept of cells

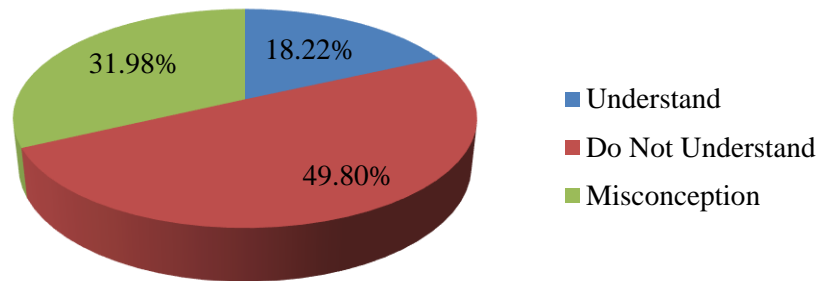


Figure 3.1 Average Understanding Level of Students in Makassar City Based on Diagnostic Test Results on Cell Concepts. (Source: Researcher Data, 2018)

The description of the description of Figure 3.1 can be seen in Table 3.1 about the level of understanding of students in Makassar City based on the results of diagnostic tests on 6 Basic Competencies (BC) about cell concepts.

Table 3.1 Percentage of Students' Understanding Level in Makassar City Based on Diagnostic Test Results with CRI Method on 6 Basic Competencies (BC) about Cell Concepts

No.	Basic Competence	Understanding Level		
		Understand (%)	Not Understand (%)	Misconception (%)
1	3.1 Describe the chemical components of cells, structures, and cell functions as the smallest units of life, identifying cell organelles through observation	24.50	42.97	32.53
2	3.2 Comparing the transport mechanism in the membrane (diffusion, osmosis, active transport, endocytosis, and exocytosis) from observations	18.35	42.94	38.71
3	4.1 Conduct microscopic observations of onion layer tuber cells and cheek epithelial cells, identify their constituent organelles and their functions	36.92	45.03	18.05

4	4.2 Experiment with diffusion and osmosis by using potato tubers or spinach or salted stem and linking them to trans membrane transport events	7.98	42.55	49.47
5	3.2 Understand the role of enzymes in the metabolic process and present data on metabolic processes based on the results of investigations and literature studies to understand the process of energy formation in living things	14.98	57.26	27.76
6	3.3. Analyze the process of cell division	6.56	68.06	25.38
	Average	18.22	49.80	31.98

Source: Researcher Data, 2018

3.2. Discussion

The results showed that there were misconceptions of high school students in Makassar City on the concept of cells of 31.98%. This value is almost comparable with the level of understanding of students who do not understand the concept of 49.80%. while those who understand the concept are only 18, 22%. Misconceptions that occur in students can be caused by various factors including books that are used and can also be sourced from teachers, such as the research previously known that there were also misconceptions on teachers in schools where data was collected [14]. Misconceptions that occur in students in more detail can be explained in the following explanation, Level of Understanding of High School Students in Makassar City on Cell Concept

3.2.1. Understand. The results showed that the level of understanding of high school students in Makassar City on the concept of cells that understood the concept was 18.22%. The percentage of understanding the highest concept is found in BC number 4.1, which is 36.92%. BC number 4.1 consists of 1 indicator with 1 question.

Based on the results of the study it was also known that the percentage of students who understood the highest concept were in items number 1, 4, 7 and 10, which were 7.28%, 7.36% 6.74%, and 7.63. Questions number 1, 4, and 7, are questions of BC number 1 translation, which describes the chemical components of cells, structures, and cell functions as the smallest units of life, identifying the cell organelles through observation. While the item number 10 becomes the most understood problem for students because when the teacher delivered this material assisted learning media in the form of pictures, so that students more easily remember the descriptions and functions of the structure. The results also show that item number 16 has a high percentage of students who understand the concept, which is 5.50%.

3.2.2. Not Understand. Based on the results of the study it was found that the percentage of students in Makassar City who did not understand the concept had the highest percentage compared to the other two categories of understanding, namely 49.80%. The results also show that the percentage of students who do not understand the concept occurs most in item number 19 at 5.06%. BC 3.2 and 3.4 are BC which percentage of students do not understand the highest material. This material is a fairly difficult

material, from the results of the analysis of the problem is also a difficult problem. This material is material related to the process while in most cell biology material books focuses more on structure, this is in line with the findings of several researchers that cell biology, as introduced in the school curriculum, focuses primarily on structure not on process, even though understanding of the process biology has been recognized as important for a comprehensive understanding of biological systems [16], [17].

BC 3.2 about enzymes in the metabolic process and presents data on metabolic processes based on the results of investigations and literature studies to understand the process of energy formation in living things represented by problems 16, 17, 18 and 19 with a percentage of 4.17%, 4, 96%, 4.62% and 5.06%. While BC 3.3 about the process of cell division is represented by items number 20, 21, 22, 23, 24 and 25 with a percentage of 4.93%, 4.86%, 4.93%, 4.79%, 4, respectively 21% and 4.52%. The interpretation of someone who does not understand the concept is based on the right answer but the CRI value is low or the answer is wrong and the CRI value in selecting the answer is also low [18].

3.2.3. Misconception. Based on the results of the study it is known that misconceptions on cell concepts are found in all the basic competencies that researchers carefully research (Table 3.1). The highest percentage of misconceptions is in BC number 4 (49.47%) and the lowest percentage of misconception is in BC number 3 (18.05%).

a. Students' misconceptions on basic competence 1 (BC. 1)

BC 1 consists of 6 indicators and is divided into 9 items (Table 5.1). Based on question number 1 based on the results of the study it was found that there were 5.39% of students from all students who experienced misconceptions on the concept of cells. Some students both believe that a compound that is not a constituent component of cells is H₂O and some other students believe that phospholipids are compounds that are not constituent components of cells. The actual concept according to Campbell of question number 1 is a compound that is not a constituent component of cells is lactic acid, because lactic acid compounds are respiration products anaerobically in certain fungal and bacterial cells for utilization in the milk processing industry [19].

The misconception that occurs in students is supported by the statement that says that the material of the cell structure is material that is considered difficult. While the other three subjects did not consider the material in BC number 1 difficult to learn. From the results of interviews and analysis of previous research, information was obtained that teachers who taught at these schools also experienced misconceptions on the material. The misconception that occurs with the teacher can be caused by the knowledge gained in college. The long period of lecture allows the retention of knowledge that occurs to them. This is supported by the statement of Murni which explains that misconceptions obtained from previous education will remain in someone [20]. According to Naz if misconceptions in a person are not converted into a true understanding of the concept, it will remain in them [21]

Based on the results of the study it is known that in BC number 1 the most misconceptions occur in number 8. In the item number 8 the subject of the researcher was asked to identify which of the answer choices were not mitochondrial functions. most students in Makassar City experience misconceptions for the material function of cell organelles. The students' concept of mitochondrial function, namely lipid synthesis, is correlated with problem number 9, namely the golgi apparatus has a function as a place for lipid synthesis, a place for carbohydrate synthesis, and as a place to sort and distribute products from the endoplasmic reticulum, as well as play a role in the packaging process secretions released into cells. Students are not able to distinguish mitochondrial function and golgi apparatus. It can be seen from the percentage contribution of misconception that is 5.76% for questions number 8 and 4.00% for question number 9. Material characteristics that are tested in problem number 8 need reasoning because they are related to the function of cell organelles. In line with this, explained that the lack of reasoning for the material being studied can lead to misconceptions in a person [22]

b. Students' misconceptions on basic competence 2 (BC 2)

Basic competence number 2 relates to the transport process on the membrane of the cell membrane (diffusion, osmosis, active transport, endocytosis, and exocytosis). Based on the results of the study there is a misconception in all items related to BC number 2. The highest misconceptions occur in questions number 11 and 12 of 7.04% and 5.44%. The question in item 14 is asking which of the following statements is incorrect from the exocytosis process. Some students answer questions with wrong answers and are very confident, that is there are those who answer that is not true related to the process of exocytosis is the process of transporting macromolecules out of cells, vesicles which are transported out of cells formed from the golgiapparatus, the compounds transported in the exocytosis process can in the form of protein, and compounds transported in the exocytosis process can be polysaccharides. This shows that students experience misconceptions. The correct concept according to Campbell exocytosis is the process of transporting macromolecules (can be proteins and polysaccharides) from inside cells out of cells and vesicles which are transported out of cells formed from the golgiapparatus [19]. Besides that it also happened in items 13 and 14.

Based on the analysis of the level of difficulty items number 13 and 14 are in the category of questions that are very difficult and difficult. The level of difficulty of the questions that are in the category is difficult and very difficult causing students to need high reasoning for the concept being tested. Based on the results of interviews there are many things that support the high misconception of students in BC number 2, including the learning resources used by students in the form of school printed books whose material content does not specify in detail so that it does not give a thorough understanding for students.

c. Students' misconceptions on basic competence 3 (BC 3)

In the basic competency number 3 it is known that there are 18.05% of students in Makassar City who experience misconceptions and contribute as much as 2.29% of all students who experience misconceptions on the material concept of cells. BC number 3 is translated into 1 indicator with 1 item that is item number 10. Misconceptions contained in item number 10 are two, namely: 1) students believe that the structure of phosphate in the cell membrane layer is hydrophilic, while the lipid part is hydrophobic, 2) students believe that both the phosphate and lipid parts of the cell membrane structure are not hydrophilic and hydrophobic. The real concept according is that the phosphate portion of the lipid bilayer on the cell membrane is hydrophilic while the lipid portion is hydrophobic [23]. The misconception that occurs in item number 10 is caused because students who experience misconceptions cannot reason well with the concept of cell membrane structure.

d. Students' misconceptions on basic competence 4 (BC 4)

BC number 4 is contained in one item, item number 15. There are two types of misconceptions on question number 15, namely: 1) The addition of the length of the potato put into hypotonic solution because the potential of water in the potato cell is higher than the water potential in solution, 2) Addition of the length of the potato put into hypotonic solution because the concentration of the solution is higher than the concentration of the solution in the potato cell.

The real concept is that the potato slices put into hypotonic solution, causing the addition of potato lengths from the previous size due to the potential for hypotonic dissolved water to be higher than the potential of water in the solution of potato cells causing water to move into the potato cell. This is called osmosis [19].

Item number 15 is a question item based on the application of the concept of cell osmosis in relation to real life. The misconception of students who cannot distinguish the concept of osmosis in hypotonic, hypertonic, and isotonic solutions can be obtained from the misconceptions held by these students in applying it in real life. This is in line with statement which explains that misconception can occur as a result of errors in interpreting natural phenomena in daily life [24]. According misconceptions can be obtained from natural phenomena in surrounding life [25]. In addition, this also happens because of inappropriate use of terminology, students often cannot distinguish hypotonic,

hypertonic, or isotonic. According to misconceptions can occur if the mastery of subject knowledge is inadequate and inappropriate terminology is used [7].

e. Students' misconceptions on basic competence 5 (BC 5)

BC number 5 is described into four items. Based on the results of the study it is known that there are several different student understanding with the understanding of the real experts. The results showed the high misconceptions that occurred in students in the city of Makassar on item number 19. Item number 19 includes items that have difficulty in the very difficult category. The type of misconception that occurs in students is that students believe that differences in the amount of ATP produced in aerobic respiration and anaerobic respiration can occur due to: 1) At the stage of glycolysis anaerobic respiration occurs complete decomposition of carbon compounds, 2) All stages of reaction in aerobic respiration are produced in the form of energy ATP, 3) In aerobic respiration, the results of glycolysis will immediately enter electron transport which produces large amounts of ATP, and 4) In the stage of aerobic respiration glycolysis NADH, FADH, and ATP are produced in large numbers when entering electron transport.

The actual concept is the difference in the amount of ATP produced in aerobic and anaerobic respiration can occur because most of the energy in anaerobic respiration is stored in the final compound in the form of ethanol or lactic acid. The glycolysis stage only produces 2 molecules of pyruvic acid, 2 ATP, and 2 NADH, no FADH molecules are produced at the glycolysis stage. Not all stages of aerobic respiration produce ATP because the oxidative decarboxylation reaction stage does not produce ATP [19]

Based on the results of data analysis conducted by researchers, the misconception that occurred in students in Makassar City on item number 19 was due to students' reasoning about lack of metabolic material. Students must analyse in more detail which choice of answer is right for the question. Characteristics of metabolic material that requires mastery of the concept of chemistry also become an obstacle for many students to experience misconceptions. Learning concepts in biology requires subjects who study them to study thoroughly about interrelated concepts because one concept can be the basis of knowledge for other concepts [4]. The concept of biology which is mostly related to concepts in other fields both chemistry and physics causes one who studies biology must also have knowledge in the field of chemistry and physics. For example, the metabolic process is based on chemistry. This is the basis for the high percentage of misconceptions in students in Makassar City on metabolic material.

f. Students' misconceptions on basic competence 6 (BC 6)

BC number 6 is translated into 6 items. Question items number 21 and 25 are items that have the most misconceptions, which are 4.43% and 3.68% respectively.

Question number 21 relates to the identification of cell images that have one of the stages of division. There are two types of misconceptions: some students believe that the image is a metaphase phase marked by chromosomes in the cell equator. Whereas another misconception is that students believe that the image is an anaphase II phase, that is, chromatids, you separate and move toward the cell poles. The same concept is a stage of anaphase, the phase where chromatid is separated and moves toward the cell poles [23]. Item number 25 is one of the questions that has the highest percentage of misconceptions compared to other items. Material characteristics that require good understanding are assumed to be the cause of students not being able to answer the questions correctly.

The types of misconceptions that occur in item number 25 include: 1) some students believe that the number of chromosome sets in ootid is not the same as the number of chromosome sets in secondary spermatocytes, 2) some students in Makassar City believe that spermatogenesis produces 4 puppies functional whereas oogenesis produces more than one functional ovum, 3) some students believe that myosis I does not produce secondary oocytes and secondary spermatocytes, 4) and some students believe that spermatogenesis does not occur in the testes and oogenesis does not occur in the ovary. The correct concept according is the number of chromosome sets in ootid is the same as the

number of chromosome sets in secondary spermatocytes [19]. It is known that the process of chromosomal reduction only occurs in meiosis I whereas chromosomal reduction does not occur in meiosis II, so that the results of meiosis I in the form of secondary oocytes and the results of ootidiosis II have the same chromosome number.

4. Conclusion

The conclusion in this study is the understanding of high school students in the city of Makassar on the concept of cells is 18.22% of students who understand the concept of cells, 49.80% who do not understand the concept of cells, and 31.98% who experience misconceptions in the concept of cells. Misconceptions occur in all basic competencies (BC 1-6) which are tested on cell concepts, which are 32.53%, 38.71%, 18.05%, 49.47%, 27.76% and 25.38% respectively.

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