



Analysis of students' misconceptions on the material of life organization systems



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ABSTRACT

This study aims to analyze students' misconceptions on the material of life organization systems and to determine the factors that cause misconceptions in students at SMP Negeri 10 Pontianak. The research subjects were 30 students of class VIII H. The method used was case study method. Data collection techniques used diagnostic tests with CRI and non-tests in the form of questionnaires and interviews. The results showed that there were students' misconceptions on the material of life organization systems. The percentage of students' misconceptions that fall into the high category is the sub-material on the organism (73.33%). In the medium category, there are sub material organizations of life (56.67%), cells (60.83%), and organs (65.83%). In the low category, there are sub-material tissues (36.67%) and organ systems (27.5%). There are 5 factors that cause misconceptions, namely associative thinking (64.2%), incomplete reasoning (66.1%), wrong intuition (62.1%), student ability (57.1%), and student interest (54.3%).

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INTRODUCTION

Biology is a branch of natural science that examines scientific conceptions of the life of living things and the interactions between them (Mustaqim et al., 2014). According to Sudarisman (2015) biology has specific material that is different from other sciences, namely the science that studies living things, the environment and the relationship between them. One of the basic concepts that need to be understood in Biology is the concept of the cell. Cell is a concept that underlies students' understanding to study the next Biology material. The need to understand concept of cell correctly aims to avoid misconceptions in the learning process. Examples of

misconceptions that occur in the biology learning process can be seen in Mahardika's (2014) study entitled identification of student misconceptions using the Certainty of Response Index (CRI) and diagnostic interviews on concepts of cells, it is stated that students experience misconceptions on all cell concepts. For example, students state that the cell functions as a genetic unit, students state that the cytoskeleton has a tube-like shape, and students state that permeable is a membrane that is impermeable to water. Conceptual fallacies such as these are called misconceptions.

Misconceptions are conceptual fallacies that are inappropriate or different from the scientist's conceptions (Gumilar, 2016). According to Sa'idah & Suyono (2012) misconception is an inadequate interpretation (perception) of a concept. Misconceptions are unscientific concepts that exist in students' minds and can hinder the learning of correct concepts (Kaltakçi & Didiç, 2007). This misconception is an obstacle for someone to understand the concept as scientists' thoughts. This is in line with the opinion of Rafika et al., (2015) which states that misconceptions are a latent danger because they can hinder the learning process due to wrong logic and the emergence of interference when learning the correct new concept that does not match the wrong old concept that has been accepted, and sink into thought. Based on the research of Samiha et al., (2017) the percentage of misconceptions in science subjects, especially life organization system, is greater than the material characteristics of living things and the cause comes from the teacher's method and the passiveness of students in seeking information.

The causes of misconceptions are more understandable from the point of view of constructivism. According to the constructivism view, knowledge is formed (constructed) by students themselves in contact with the environment, challenges, and the material being studied (Suparno, 2013). Because the knowledge is formed by the students themselves, it is possible for errors to occur in constructing knowledge. In the knowledge construction process, there can be incomplete knowledge construction by students due to their limited abilities and mixed with other ideas, in this case misconceptions are easier to occur. So even though the teacher conveys the same material, students will still process and digest the material according to the knowledge construct by them, because the teacher cannot simply impose the knowledge they have on the students. This is in accordance with the opinion of Yuliati (2017) which states that each student has different experiences that allow students to have a wrong understanding of a concept.

Suparno (2013) states that in the development of constructing knowledge, students start from very simple and incomplete concepts, slowly in the learning process becoming more complete, precise, and correct. Even though it is a process, this misconception should not be left alone, because if left unchecked then the process of becoming perfect will not occur and will even have an impact on the unattainability of optimal student learning outcomes. This is supported by the opinion of Ramadhan et al., (2017) which states that misconceptions that occur in students should not be left for too long which causes a lack of student learning outcomes.

Based on the daily test score data of grade VII of SMP Negeri 10 Pontianak, it was found that student learning outcomes on the life organization material have an average value of 76.7 and have not reached the minimum completeness criteria value (KKM) which is 82. Low learning outcomes are one of the characteristics of the impact of misconceptions (Siwi in Subrata et al., (2019).

Based on the results of a pre-research conducted on 10 students of SMP Negeri 10 Pontianak in grade VII of 2018/2019 academic year on the material of the life organization system, several errors were found in the students' answers. 50% of students were still wrong in arranging the level of organization of life from simple to complex, 70% of students were wrong because they mention the cell wall is included in the main part of the cell, 20% of students are wrong in mentioning the function of the cell nucleus, 30% of students were wrong in mentioning the function of ribosomes, 40% of students incorrectly mention the function of the Golgi

apparatus, 70% of students incorrectly mentioned the function of chloroplasts, 40% of students incorrectly mentioned the function of mitochondria, 30% of students incorrectly named the organs that make up the organ system in animals, and 30% of students incorrectly named the organs that make up the organ systems in plants.

From the results of the interview stated that students still have difficulty in remembering various cell organelles and their functions, as well as the number of tissues in animals and plants that must be remembered. Examples of misconceptions experienced by students are assuming that cell walls are also found in animal cells. In addition, students also assume that only plants produce chlorophyll because of the presence of chloroplasts. However, according to Campbell et al., (2014) chloroplasts contain a green pigment called chlorophyll, as well as various enzymes and other molecules that function in the production of sugar by photosynthesis. Chloroplasts do not produce chlorophyll but are places where chlorophyll, molecules, and other enzymes are found to produce sugar through the process of photosynthesis with the help of sunlight.

The results of research by Mustaqim et al., (2014) on students' misconceptions on photosynthesis and plant respiration material state that misconceptions that occur in students can be identified and analyzed using several ways, one of which is using a diagnostic test in the form of multiple choice with open reasons accompanied by Certainty of Response Index (CRI) but in this study, the causes of misconceptions that occur in students are not sought. Based on these, this research aims to analyze students' misconceptions on the material of life organization systems and find out the factors that cause misconceptions in students of SMP Negeri 10 Pontianak.

RESEARCH METHODS

Research Design

The method used in this research is descriptive method. Descriptive research is a method that aims to describe the conditions of groups and individuals as they are, do not manipulate independent variables, and describe conditions with numbers (Sukmadinata, 2012). The form of research used is case study because this research will focus intensively on a particular object and study it as a case. The case in this study is students' misconceptions on the material of life organization systems in SMP Negeri 10 Pontianak.

Population and Samples

The subjects of this study were students of grade VIII H at SMP Negeri 10 Pontianak of academic year 2019/2020 which consisted of 30 students. The research sample was taken using a purposive sampling technique, namely sampling with a specific purpose (Sugiyono, 2017).

Instruments

Data collection techniques using tests and non-tests. The test instrument uses 20 multiple-choice diagnostic test questions accompanied by open reasons equipped with a level of confidence. The non-test instrument used a questionnaire and interviews with students. Diagnostic test questions in the form of 20 multiple choice questions were used to identify students' misconceptions on the material of life organization systems. Questionnaires are used to find out misconceptions that are not explored through diagnostic tests and also to look for factors causing students' misconceptions. Meanwhile, interviews were conducted with the aim of further exploring students' misconceptions related to diagnostic tests accompanied by CRI and questionnaires on the material of life organization systems. Before being applied, the research instrument was validated by 3 validators consisted of 2 biology education lecturers and 1 science teacher. The validation value is 1.00 so that the research instrument is declared feasible to be used for research.

Procedures

This research consists of three stages, namely the preparation stage, the implementation stage and the data processing and report preparation stage.

Preparation Stage

The steps taken are (1) Conducting a preliminary study; (2) Pre-research; (3) Develop research instruments; (4) Validation of research instruments; (5) The trial of diagnostic test instruments accompanied by CRI; (6) Making interview guidelines; and (7) Determine the research schedule.

Implementation Stage

The steps taken are (1) Carrying out diagnostic tests accompanied by CRI; (2) Recap the results of the answers; (3) Determine the category on the CRI rating scale; (4) Determine the category of misconceptions in students' answers; (5) Conducting a misconception analysis of students' answers; (6) Performing the calculation of the percentage of misconceptions; (7) Grouping the results of diagnostic test answers with CRI into 3 (three) categories, namely high, medium, and low categories; (8) Determine 5 students to be interviewed by taking students from high, medium, and low categories; (9) Students fill out a questionnaire; (10) calculate student questionnaire scores and analyze student answers; and (11) Conducting interviews with 5 students.

Data Processing and Report Preparation Stage

The steps taken were (1) analyzing data from the research results of diagnostic tests, questionnaires, and interviews; (2) draw conclusions on the results of data analysis of research results; and (3) Compiling research reports..

Data Analysis

Data analysis was performed on the three instruments used. First, the results of the diagnostic test with CRI were recapitulated and then categorized according to the CRI rating scale so that the percentage of students who experienced high, low and moderate misconceptions could be calculated. The results of the questionnaire are recapitulated and the answers will be converted into quantitative data for later analysis so that the cause of the misconceptions experienced by students can be determined. There are five sub-factors that cause misconceptions, namely associative thinking, incomplete reasoning, wrong intuition, student abilities and student interests. The results of the interviews will be used to describe the factors that cause misconceptions. The following are the results of the diagnostic test with CRI (Certainty of Response Index):

1) Category CRI Scale (Table 1)

Table 1. Category CRI Scale

Scale	Category
0	Totally guessed answer
1	Almost a guess
2	Not sure
3	Sure
4	Almost certain
5	Certain

2) Misconception Category (Table 2)

Table 2. Misconception category

Answer	Reason	CRI Value	Description	Code
Correct	Correct	> 2,5	Understand the Concept	PK
Correct	Correct	< 2,5	Understand the Concept but Not Convinced	PKKY

Correct	Wrong	> 2,5	Misconception	M
Correct	Wrong	< 2,5	Not Knowing the Concept	TTK
Wrong	Correct	> 2,5	Misconception	M
Wrong	Correct	< 2,5	Not Knowing the Concept	TTK
Wrong	Wrong	> 2,5	Misconception	M
Wrong	Wrong	< 2,5	Not Knowing the Concept	TTK

3) Misconception Percentage Calculation

$$\% = \frac{\sum N}{N} \times 100 \text{ (Arikunto, 2015)}$$

Explanation:

% : percentage of students' misconceptions

$\sum N$: number of students with misconception category

Nt : total number of students

4) Standards for Categorizing the Percentage of Misconceptions (Table 3)

Table 3. Standards for Categorizing the Percentage of Misconceptions

Category	Percentage
High Misconception	> 23,45 (78,1%)
Moderate Misconception	6,14 (20,4%) – 23,45 (78,1%)
Low Misconception	< 6,14 (20,4%)

RESULTS

The results obtained based on diagnostic tests accompanied by CRI regarding the percentage of students' misconceptions for each sub-material can be seen in Table 4.

Table 4. Percentage of Students' Misconceptions for Each Sub Material

No	Sub Material	Question Number	Number of Students Misconceptions	$\sum N$	Nt	Percentage of Misconceptions in Each Sub Material (%)	Misconception Category
1	Life Organization	1	21	34	60	56,67	Moderate
		3	13				
		4	29				
2	Cell	5	3	73	120	60,83	Moderate
		6	28				
		7	13				
		8	16				
3	Tissue	9	13	55	150	36,67	Low
		10	13				
		11	6				
4	Organ	12	7	79	120	65,83	Low
		2	24				
		13	21				
		14	6				

No	Sub Material	Question Number	Number of Students Misconceptions	$\sum N$	Nt	Percentage of Misconceptions in Each Sub Material (%)	Misconception Category
		16	28				
5	Organ System	15	2	33	120	27,5	Low
		17	20				
		18	6				
		19	5				
6	Organism	20	22	22	30	73,33	High
Average						53,47	

Explanation: $\sum N$ is the total number of students who experience misconceptions in each sub material; Nt is the total ideal student for each sub material (Number of students x number of questions in one sub material)

The results of the percentage of factors that cause students' misconceptions, the results of data analysis from the questionnaire given to students for each factor can be seen in Figure I.

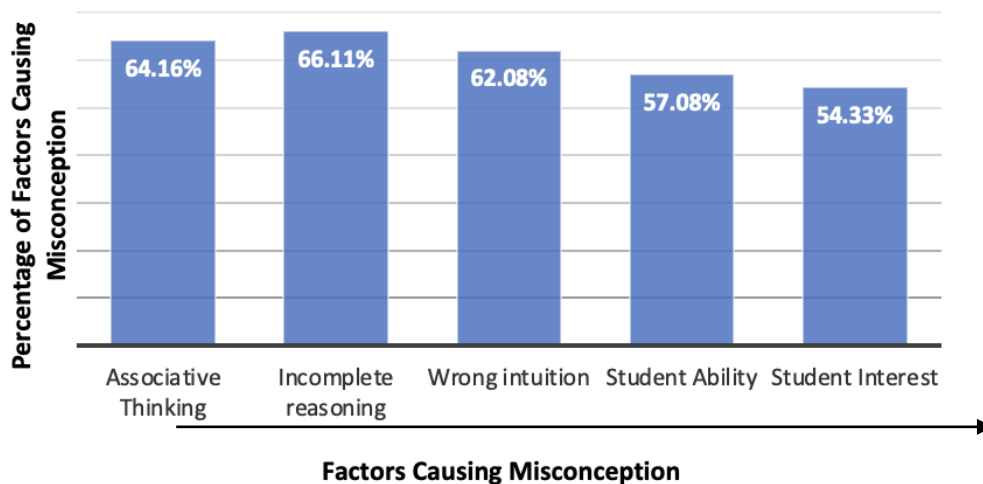


Figure I. Percentage of Factors Causing Students' Misconceptions

DISCUSSION

Misconception

Based on the results of the study in Table 4 about the percentage of students' misconceptions for each sub material of the life organization system. In the sub material of the organization of life which consists of 2 items, the highest misconception is in item number I. A total of 21 students answered the correct answer with the wrong reason and chose a CRI score > 2.5. Students answer organizational systems starting from simple ones, namely cells, then tissues, organs, organ systems, and organisms. The reason students answer that way is because according to students, cells are the smallest unit so that they are in the first order, tissues at the second level, organs at the third level, organ systems at the fourth level and organisms at the fifth level. Based on these reasons, it is known that students only reaffirm the levels they have memorized without knowing why the order from simple to complex is like that. The correct scientific concept starts from the cell as the smallest unit, then cells with the same shape and function will form a network, a combination of several tissues will form an organ, a collection of several organs will form an organ system and the cooperation of all organ systems will form a single unit called an organism.

The results of Subrata et al.'s research (2019) also found that 24, 77% of 42 students at SMP Negeri 14 Pontianak experienced misconceptions in the sub material of the organization of life. The low level of student reasoning is one of the causes of this misconception. According to Ma'arifah et al (2012) a low level of reasoning causes students to be unable to think deductive, proportional, combinatorial and reflexive hypotheses so that knowledge cannot be captured properly. In addition, according to Rahmat et al (2015) reasoning skills are needed by students to process information during the learning process.

The second sub material, namely cells, consists of 4 questions. The highest misconception is found in item number 4 where students are asked to determine the correct statement about cells. A total of 29 students answered incorrectly, with the wrong reasons and chose a CRI score > 2.5 . Most students have misconceptions that cells are the smallest living things that make up the body. The reason students answer that way is because cells are the smallest living things and because cells are the simplest organisms. Based on these reasons, students assume that the cell is closely related to the words "smallest" and "simple". Rafika & Rachmadiati (2015) found that 17.97% of the 79 students had misconceptions in the cell sub material. According to Campbell et al., (2014) cell is the smallest organizational unit that can carry out all the activities necessary for life. According to the cell theory, all living organisms are made of cells, which are the basic unit of life as all the actions of organisms are based on the function of the cell. For example, eye movements when reading are produced from the activity of one of them, namely nerve cells. According to Subrata (2019) the causes of misconceptions experienced by students are the characteristics of the cell material, the knowledge that comes from the students themselves, the abilities and learning methods applied by the teacher, and the use of textbooks that are less than optimal.

The third sub material is a network consisting of 5 questions. The highest misconception is found in item number 8, where students are asked to determine one of the network examples correctly. A total of 16 students experienced misconceptions, 12 of whom answered the correct answer with the wrong reason and chose a CRI score > 2.5 and 4 students answered the wrong answer, with the wrong reason and chose a CRI score > 2.5 . Students answer blood as an example of a tissue that plays a role in the work of the transportation system, with reasons including, because blood is the organization of life; because blood functions to circulate nutrients, oxygen, and others throughout the body; because blood is the organization of life at the tissue level; because blood is a carrier tissue. Based on these reasons, it is known that students have a wrong concept about the network. The correct concept is that a tissue is a group of cells that have the same shape and perform the same function. So blood is an organization of life at the tissue level because blood is composed of a collection of cells that have the same function. In addition, 4 students answered that the heart is an example of a tissue because the heart plays a role in the transportation system. The concept is clearly wrong because the heart is an organ-level organization of life. In line with this, Sundari and Bashri (2018) also found that as many as 78.57% of students experienced misconceptions about the meaning of the network. In addition, Sartika et al (2020) also found that 40.52% of 165 students experienced misconceptions in the network sub material. Misconceptions in this basic concept can cause students to not be able to understand the right network concept.

The fourth sub material is the organ which consists of 4 questions. The highest misconception is found in item number 16, where students are asked to choose the correct statement regarding the difference between tissues and organs. A total of 28 students experienced misconceptions by answering wrong answers, wrong reasons and choosing a CRI value > 2.5 . Students who experience misconceptions answer that organs are a collection of the same tissue by giving the reason that the same cells form tissues, while the same tissues together will form organs. The reason is wrong because the correct scientific concept is that an organ is a collection of several tissues to carry out certain functions, for example: the heart consists of epithelial, muscle,

connective, and nerve tissues. The results of Sartika et al.'s (2020) research also revealed that 40.71 students experienced misconceptions in the tissue and organ sub materials.

The fifth sub material is the organ system which consists of 5 items. The highest misconception is found in item number 17, where students are asked to analyze the relationship between liver disorders and organ systems in humans. A total of 20 students experienced misconceptions, 18 of whom answered the correct answer with the wrong reason and chose a CRI score > 2.5 and 2 students answered the wrong answer, with the wrong reason and chose a CRI score > 2.5 . Students with correct answers answered that the diseases listed in the questions can affect the work of the excretory system for reasons including, namely, excretion is a metabolic process and excretion is a disorder that can affect metabolism. The reasons given are different and not in accordance with the scientific concept because excretion is an organ system not a disorder. The results of Khairaty's research (2018) also show that 56.21% of 37 students experience misconceptions in the organ system sub material, especially in the circulatory system sub material. According to Campbell et al., (2014) excretion functions for the disposal of metabolic waste and for regulation of blood osmotic balance. Disorders of the liver as mentioned in the question will affect the work of the excretory system, because the liver is one of the organs that make up the excretory system.

The sixth sub material, namely organisms, is found in item number 20 where students are asked to determine one level of the organization of life based on the examples provided. A total of 22 students experienced misconceptions, 21 of whom answered the correct answer with the wrong reason and chose a CRI score > 2.5 and 1 student answered the wrong answer, with the correct reason and chose a CRI score > 2.5 . The student who answered correctly stated that a cat and a mango tree are examples of organism-level organization of life for the following reasons, namely, because a cat and a mango tree belong to the organizational level in life, because a cat is an animal and a mango tree is a plant, because the cat and the mango tree are the organization of life at the level of the organism, and because a cat and the mango tree are the organization of life at the level of the organism's life. Based on these reasons, it is known that some students wrote the same reasons as the questions given. Students who answer that a cat and a mango tree are organisms because cats are animals and mango trees are plants are a misconception. This is because students do not know what is meant by an organism. While the correct concept is that the cooperation of organ systems will form an organism.

Most of the students who fall into the category of misconceptions answered with correct answers, wrong reasons, with CRI scores > 2.5 ; and choose the wrong answer, the reason is wrong, with a CRI value > 2.5 . This is in accordance with the description of Hakim et al., (2012) that there are three categories of answers that indicate the student is a misconception, namely students answer correctly with wrong reasons and CRI scores > 2.5 , students answer incorrectly with correct reasons and CRI scores > 2.5 , and the student answered incorrectly, with the wrong reason and the CRI score > 2.5 .

Percentage of students' misconceptions

The sub-material with the highest category of misconceptions is found in the organism sub-material (73.33%). Sub materials with the category of moderate misconceptions are found in the sub materials of the organization of life (56.67%), cells (60.83%), and organs (65.83%). Low sub material is found in tissue sub material (36.67%) and organ system (27.5%). Cell sub-material is a sub-material that should be thoroughly understood so as not to experience continuous misconceptions in the next sub-material. Misconceptions in the cell sub material are also found in Mahardika's research (2014) which states that high school students experience misconceptions that exist in all cell concepts, which include cell chemical components, cell structure and function, plant and animal cell organelles, and transport mechanisms in membranes.

Factors that cause students' misconceptions

The causes of misconceptions described by Suparno (2013) that according to him there are 5 factors that cause misconceptions, namely associative thinking, incomplete reasoning, wrong intuition, student abilities, and student interests. Based on the results of the study in Figure 1, it is known that the first factor is associative thinking, students agree that many foreign terms in the material of life organization systems are confused in their minds. Based on research conducted by Herdani et al., (2015), it is known that students have difficulty in understanding biology lessons due to several factors, namely because of quite a lot of memorization, difficulty in remembering foreign and Latin terms, and the learning media used is less attractive. If it is difficult to understand the terms and their meanings are confused, it will be the cause of students' misconceptions.

The second factor is incomplete reasoning. Most of the students agreed that they were not able to explain clearly when the teacher asked for an explanation and they did not seek information in concluding about the material of living organization systems. Misconceptions that occur in students are due to errors in student reasoning caused by lack of information in finding material so that they cannot provide a complete explanation. This is in accordance with the opinion of Comins (in Suparno, 2013) which says that misconceptions can also be caused by students' wrong reasoning.

The third factor is wrong intuition. Most of the students strongly agreed that they answered the questions based on the feelings they thought were true. Supported by the results of interviews, students (H19 and H30) revealed that they answered spontaneously according to their feelings when filling out the questions. According to Suparno (2013), intuition can also cause misconceptions because intuition is a feeling in a person who spontaneously expresses his attitude or idea about something before being objectively and rationally investigated. This causes students to be less critical in thinking so that they think of spontaneous answers that they think are correct, thus causing misconceptions.

The fourth factor is the ability of students. Most of the students agree that they have difficulty in understanding the material of living organization system because there is too much memorization of the material. This is reinforced in the interviews of students (H10, H19, H30, H21 and H11) who are less able to memorize or understand all the material on the life organization system contained in the book because the language of the book is too standard and difficult to understand.

The fifth factor is student interest. Some students agree that they rarely ask questions if they are still confused with the material and are not accustomed to reading the material before getting an explanation from the teacher in class. This is reinforced by the results of interviews, where students answered that they were less interested in learning the material. Based on this, it can be concluded that some students are less interested in the material of life organization systems but must continue to follow the lesson in order to get good grades so that the learning patterns carried out by these students become fixated on things or only memorize important material and not completely understand the material. Based on the research of Khairaty et al., (2018), one of the causes of student misconceptions in biology subjects is the lack of student interest because they assume that biology subjects use a lot of scientific terms used and tend to memorize a lot of concepts. In addition, according to Rofi, ati et al., (2014) cell material contains concepts that are abstract and quite complicated so that students find it difficult to understand cell material.

CONCLUSION

Students experience misconceptions in the sub-materials of the organization of life, cells, tissues, organs, organ systems, and organisms. The percentage of students' misconceptions that are included in the high category is in the organism sub material (73.33%). In the medium category,

there are sub-materials of the organization of life (56.67%), cells (60.83%), and organs (65.83%). In the low category, there are sub-materials of tissue (36.67%) and organ systems (27.5%). Students' misconceptions can be caused by several factors including associative thinking factors (64.2%) there are foreign terms that are often confused in students' minds, incomplete reasoning factors (66.1%) namely students cannot explain and conclude about the material due to lack of information. obtained and inaccurate reasoning, the wrong intuition factor (62.1%) that students answered based on feelings and spontaneously, the student ability factor (57.1%) namely students were less able to do their own assignments and preferred to work together with friends, and the student's interest factor (54.3%) that is, students are less interested in learning the material of life organization systems because there are too many memorizations. The results of this study are expected to be the basis for biology teachers to be able to choose appropriate strategies, media and learning resources according to the needs and constraints experienced by students so that students' misconceptions can be minimized and overcome.

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