

MISCONCEPTION PROFILE OF 11TH GRADE HIGH SCHOOL STUDENTS ON MEMBRANE TRANSPORT USING THREE TIER DIAGNOSTIC TESTS

Tyas Tania Azqiya

Biology Education Undergraduate Study Program, Faculty of Mathematics and Natural Sciences,
State University of Surabaya
C3 Building 2nd Floor Ketintang Street, Surabaya 60231
Email: tyastania15@gmail.com

Yuni Sri Rahayu

Biology Education Undergraduate Study Program, Faculty of Mathematics and Natural Sciences,
State University of Surabaya
C3 Building 2nd Floor Ketintang Street, Surabaya 60231
Email: yunirahayu@unesa.ac.id

Abstract

The learning method in Indonesia employed distance learning during the Covid-19 pandemic with the purpose that the Ministry of Education and Culture released a decree number 719/P/2020 on Diagnostic Assessment, of which one was meant to identify misconceptions with the intent that teachers must carry out. Identification of misconceptions needs to be done because it can interfere with the formation of concepts in the next material because there are several concepts that are correlated with other concepts. Cognitive assessment is one tool to recognize students that have misconceptions. The objective of this descriptive evaluative research is to assess the profile of students' misconceptions and the factors that have contributed to misconceptions faced by students in membrane transport sub materials using the Three Tier Diagnostic Test, and justification of some concepts at the highest misconceptions. The research phase consisted of validation of the test instrument, testing the student using the test instrument, analyzing the outcomes of the sample using a table for grouping students' conceptions and parameters for deciding the level of misconceptions, and drawing the conclusions. The target of this research is 40 students of State High School 1 Babat in 11th grade that was XI Science 1 and XI Science 2 classes. The findings revealed that the misconception profile of students who understand the concept, do not understand the concept, and have encountered misconceptions were 9.625%; 31.250%; and 59.125% respectively. Students who experienced misconceptions were divided into three criteria for the level of misconception, a namely high misconception by 45.00%, a moderate misconception by 37.50%, and low misconception by 17.50%. Factors that affect the misconceptions faced by students were teacher, teaching method, learning media, students' textbooks, and including students themselves. This research implies that students experience more misconceptions than understand the concepts.

Keywords: Membrane Transport, Misconception Profile, Three Tier Diagnostic Test

INTRODUCTION

Learning in biology defines a series of learning opportunities to understand scientific concepts and processes. Comprehension of biology concepts and experimental processes is linked to make biology a dynamic science (Puspitasari & Yuliani, 2020). The study of biology includes various of life, so understanding the concept of biology is very important. The importance of understanding the biology concept is by linking this knowledge with the students' real life. The whole process of education builds understanding and connection of something about life. The world of education needs to evolve continuously to support future development, one of which is through the teaching and learning process.

The capability of students to embrace and recognize concepts is essential because the concept is the foundation of thought. The mastery of students' concepts depends on the students' initial knowledge, if the knowledge of a concept that is embedded in students is not in line with scientific concepts then this is called a misconception.

According to Ibrahim (2012), misconceptions include students' plain conception, textbooks, teachers, and the use of learning methods used by teachers. Misconceptions faced by students can be a barrier to the adoption of a concept. In addition, misconceptions also lead to the application of wrong concepts in everyday life, for example, a misconception about a lunar eclipse leads to the wrong action, namely hitting anything that can sound to drive out the giants that eat the moon.

Furthermore, students who encounter misconceptions may also interfere with the preparation of scientific concepts in the next material, because several concepts are that are correlated with other concepts (Ramadhani, 2016).

In certain biological terms such as photosynthesis and respiration of plants, misconceptions amongst students exist. In its several research, half of the misconceptions of students and very few comprehend the concept was demonstrated (Machshunah & Yuliani, 2019).

Covid-19 is the disease caused by the coronavirus, namely Sars-Cov-2 that attacks the majority of the world's population and affects numerous sectors, particularly educational ones. The Ministry of Education and Culture published a Curriculum of Emergency Preparedness in Education Units, namely Decree of the Minister of Education and Culture of the Republic of Indonesia Number 719/P/2020, which means that the Department of Education in exceptional situations will introduce a curriculum that is in line with the needs of students.

The emergency curriculum is carried out during a pandemic, in this curriculum, the education units implement an online distance learning system (Arini et al., 2020). Distance learning leads to a challenge in learning from home and a concern about the teachers' various assignments and does not seem to lack concentration to the teacher during learning in such a way that students do not exclude themselves from misconception.

Teachers are expected by the Minister of Education and Culture to perform a diagnostic assessment to help students who are impacted and possibly left behind and diagnose the cognitive and non-cognitive status of students. Cognitive assessment is a method of diagnostic assessment that is supposed to be implemented by the teacher to measure the abilities and learning of students and one way to diagnose misconceptions of students in such a way that teachers need to select and describe learning methods that are by the learning needs of students. Therefore, this research attempts to illustrate the profile of membrane transport sub material misconceptions, also evaluating the possibility of alternative diagnostic assessments that teachers may conduct, and shows the correct concept on misconception with the highest percentage.

Insights regarding misconceptions are important to improve concepts that were first accepted by students so that the collaboration between the first concept is accepted and the new concept can be understood properly. The accurate identification of misconceptions

encountered by students or the lack of comprehension of the definition makes for successful handling, but if the process of detection is incorrect, students will encounter misconceptions again (Kirbulut & Geban, 2014). Recognizing the significance of this, it is important to hold a diagnostic test to assess the shortcomings of students in understanding the concept of membrane transport sub materials.

Diagnostic assessments are a reliable way to recognize student misconceptions. The Three Tier Multiple Choice Diagnostic Test is an expansion of the diagnostic with two-tier only. The Three Tier Multiple Choice Diagnostic Test is a legitimate tool for assessing student learning results and is effective for finding students' misconceptions, so this diagnostic method is considered relatively reliable (Pesman & Eryilmaz, 2010). Although the two-tier diagnostic test cannot diagnosis students who are misconceptions because of their lack of knowledge, so the Three Tier Multiple Choice Diagnostic Test can be used as a tool for identifying misconceptions in learners and lack of students' knowledge (Pesman & Eryilmaz, 2010).

Based on the background, it is essential to recognize misconceptions about the membrane transport sub material using the Three Tier Diagnostic Test technique and to recognize the misconception profile of 11th grade students in sub material membrane transport, it is expected that this may be a reference for teachers in the determination, design, and decision-making of appropriate learning methods to minimize any misconceptions. This research aims at describing the profile of misconceptions of students and the factors leading to misunderstandings or misconceptions of students on membrane transport sub material.

METHOD

This research is descriptive evaluative research. This research was conducted by collecting data and then analyzed by grouping the students into criteria that include understanding the concept, not understanding the concept, positive misconceptions, and negative misconceptions that would lead to the conclusion.

The research was carried out in January 2021. The target of this research was 40 students of 11th grade that was XI Science in the district of Lamongan, at State High School 1 Babat. The test was based on three Tier Diagnostic Test techniques and interviews. The interview was for one biology teacher and three students. The interview was conducted to determine the source of misconceptions experienced by students by connecting the results of teacher and student interviews. Apart from

teachers and students, the teaching materials in the form of textbooks approximately one book were used as supporting information.

The results obtained from the test will be analyzed and grouped based on the categories of students' understanding which can be seen in table 1.

Table 1. Grouping Students' Understanding

First-tier	Second-tier	Third-tier	Category
True	True	Sure	Understand the concept
True	False	Sure	Positive misconceptions
False	True	Sure	Negative misconceptions
False	False	Sure	Misconception
True	True	Not sure	Not understand the concept
True	False	Not sure	Not understand the concept
False	True	Not sure	Not understand the concept
False	False	Not sure	Not understand the concept

Source : (Gurel et al., 2015)

After grouping the data, the following step is to calculate the percentage of student understanding in each category. The interpretation of the data is calculated using the following formula.

$$P = \frac{f}{N} \times 100\%$$

Description:

P = Percentage of conceptual understanding

F = Number of students in each category

N = the total number of students

The percentage calculation is used to classify the level of student misconceptions which can be seen in table 2.

Table 2. Percentage Assessment Criteria for Misconceptions

Criteria	Percentage
High	61% - 100%
Moderate	31% - 60%
Low	0% - 30%

Source : (Suwarna, 2013)

FINDINGS AND DISCUSSION

Based on the outcomes of the assessments performed by students using the Three Tier Diagnostic Test method, the profile data of the students' misconceptions can be assessed in three parts: understand the concept, not

understand the concept, and misconception. The findings of the research are seen in Figure 1.

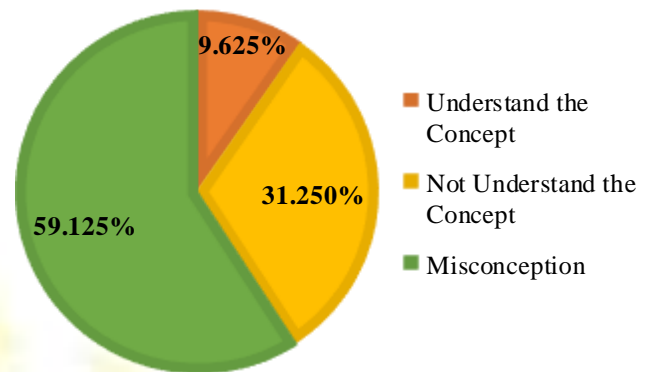


Figure 1. Average Percentage of Students' Misconception Profile

Based on Figure 1, it can be seen that students who experience misconceptions and do not understand the concept are still relatively high, namely, with a value of 59.125% and 31.250% respectively, compared to those who understand the concept, the percentage is relatively low (9.625%). Students who can understand a concept have a higher degree of understanding than students who do not understand concepts and misconceptions. Students who understand the concept can respond accurately at the first and second levels and answer questions confidently. The percentage of each criterion level of the misconception is presented in Figure 2.

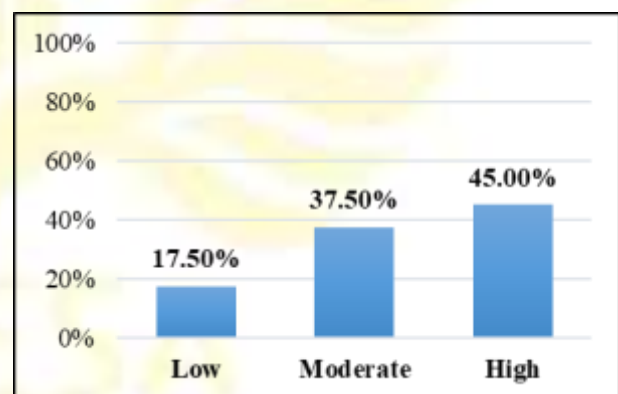


Figure 2. Percentage of Students' Level of Misconception Criteria

Figure 2 shows that the percentage of low misconceptions is 17.50%, moderate misconception is 37.50%, and high misconception is 45.00%. There are relatively high misconceptions compared to low and moderate misconceptions. The results also showed that in all indicators, misconceptions occurred in students.

The conception data of students on each sub-material membrane transport test item is presented in Table 3.

Table 3. Percentage of Students' Conceptions on Each Concept of Membrane Transport

Concept	Indicators	M (%)	UC (%)	NUTC (%)
Passive and active transport mechanisms	Examining the mechanism of passive transport and active transport	61.67	7.50	30.83
Passive and active transport processes	Comparing passive transport and active transport processes	58.33	2.50	39.17
Diffusion and osmosis mechanisms	Examining the mechanism of diffusion and osmosis	60.00	1000	30.00
Diffusion and osmosis processes	Differentiating diffusion and osmosis processes	59.37	13.75	26.88
Endocytosis and exocytosis mechanisms	Diagnosing the process mechanisms of endocytosis and exocytosis	60.83	8.33	30.83
Endocytosis and exocytosis processes	Comparing the processes of endocytosis and exocytosis	54.17	14.17	31.67

Description:

M = Misconception

UC = Understand the concept

NUTC = Not Understand the Concept

As stated in Table 3, it found that the highest level of misconceptions among students regarding the idea of passive and active transport mechanisms was 61.67%. Students also encounter misconceptions with a ratio of $\geq 50\%$ across all concepts, including 58.33% concept of passive and active transport processes, 60% concept of diffusion and osmosis mechanisms, 59.37% concept of diffusion and osmosis processes, 60.83% concept of endocytosis and exocytosis mechanism, and 60.83% concept of osmosis processes.

The highest misconception on the concept of passive and active transport systems with the indicator "Analysis of the mechanism of frequency of passive and active transport" was 61.67%. The question on this definition object reads: "the correct statement regarding passive transport is ..." In passive transport, where the mixture is extremely permeable, the carrier must maintain a concentration gradient across the membrane (Vermaas et al., 2019). The example of passive transport is diffusion and osmosis. Plants need carbon dioxide during photosynthesis. Carbon dioxide diffuses into the leaves

via the stomata. The leaves produce oxygen and water vapor and will diffuse out through the stomata. For example osmosis, water enters plant roots which function as a semipermeable membrane. The inside of the root contains minerals, sugar, and water-soluble salts. When water is available in the soil it flows through the root wall into the interior. When plants absorb water, pressure builds up on the inside. Osmotic pressure keeps the water in balance with the pressure of the water already inside, keeping plants from breaking.

Misconception faced by students on the concept of the mechanism of endocytosis and exocytosis with the indicator "Diagnosing the process mechanism of endocytosis and exocytosis" was 60.83%. The questions on this concept item relate to the applicability of the endocytosis mechanism. Endocytosis is the main route of absorption by vesicles derived from the plasma membrane of substances from outside the environment (Joshi et al., 2020).

Students experience misconceptions on the concept of diffusion and osmosis mechanisms with the indicator "Examining the mechanisms of diffusion and osmosis" was 60.00%. The questions on the elements of this concept relate to the understanding of the information of osmosis. Osmosis is the displacement of water from the dilute concentration (hypotonic) to the condensed (hypertonic) by going through the semipermeable membrane. A semipermeable membrane is a membrane through which only water and its molecules can pass through (Ulfa et al., 2020).

The concept of diffusion and osmosis processes with the indicator "Differentiating diffusion and osmosis processes" has a misconception of 59.37%. The highest misconception on the items was related to the application of the osmosis process. Osmosis is a natural event that can normally be found in plants and animals. In everyday life, it can be found in plants, the main role of osmosis is in the process of absorbing water from the soil by the roots (Sari et al., 2018).

Misconceptions also occur in the concept of passive and active transport processes with the indicator "Comparing passive transport and active transport processes", whereas the misconceptions of students in this concept are 58.33%. The highest misconception is found in the articles concerning the concept of the Sodium-Potassium ion pump. Sodium-potassium ion pumps have a role to play in regulating the balance between three sodium ions and attracting two potassium ions (Angelika et al., 2020).

The concept of endocytosis and exocytosis processes with the indicator "Comparing the processes of

endocytosis and exocytosis”, misconceptions experienced by students was 54.17%. The most serious misconception experienced by students is related to differences in endocytosis and exocytosis. Endocytosis is a cellular mechanism for controlling the composition of the plasma membrane to control cell signaling for adherence, migration, and morphogenesis (Haucke & Kozlov, 2018). The exocytosis process is the movement of molecules from intracellular to extracellular, by means of vesicles or membrane-bound pockets, which are generally made from the Golgi apparatus (Budriawan et al., 2019).

Students that encounter misconceptions can be induced by a variety of causes, including students themselves, textbooks, teachers, and the use of teaching methods (Ibrahim, 2012). Biology teachers who instruct and students that have been interviewed are six variables that have been indicated during the interview, including students, teachers, learning methods, teaching resources in the form of books, learning media, and teaching methods, and the daily context that can be found in Table 4.

Table 4. Recapitulation of Students Interview Results

Causative Factors	Students' Response
Students	a. Membrane transport sub material obtained from the internet and books. b. Students find it difficult to learn membrane transport because they don't understand it.
Teacher	a. Material delivery by the teacher during classroom learning. b. The teacher delivers the material according to the textbook. c. No concept of membrane transport is skipped.
Learning Media and Teaching Method	a. The teacher never delivers the concept of membrane transport using instructional media. b. The teacher explains the material briefly.
Textbooks	a. The concept in the book is not complete. b. The questions on the test items are in accordance with the explanations in the book.
Context	Students have discussed membrane transport sub material with friends or other people.

More students encountered misconceptions than students who understood concepts and did not understand concepts is 59.125% and students experienced misconceptions in all concepts. Figure 2 reveals that there are higher misconceptions, i.e. 45.00%, than low and medium misconceptions. The misconceptions faced by students are attributed to a lack of knowledge of sub-material membrane transport. This opinion is reinforced by the response of students to the

results of the interview that students receive membrane transport sub-materials from the internet, brief descriptions from teachers, and a variety of books. In addition, the concept in the textbook used as a reference is incomplete. Solutions for students if they have difficulty learning membrane transport, students can use a strategy of summarizing or making concept maps or mind maps to make it easier to understand the material and the students having discussions with experts so misconceptions do not occur. While the solution for the teacher, should provide a practicum using simple media, for example for diffusion application, the students can add sugar to fresh tea, while the osmosis application can use tubers such as potatoes or sweet potatoes and sucrose solutions with different concentrations. Practicum can strengthen the concepts received by students. These practicum activities can be carried out independently by students during online or offline learning but must be in accordance with teacher directions. Besides the interview with the students, the biology teacher was also interviewed. The results of the interview can be seen in Table 5.

Table 5. Recapitulation of Teacher Interview Results

Aspect	Response
Learning Method	The method used by the teacher is the method of discussion, lectures, and experiments.
Difficult Concept	a. Teachers find it difficult to teach students about the different concepts of solution and solvent. b. The teacher teaches by conducting experiments and clarifying the concept of the experimental results.
Frequent Misconceptions	Osmosis. The cause of this misconception is the lack of understanding in students.

From the evidence from Table 5, it can be shown that the teacher who teaches is also a factor that creates misconceptions faced by students. The findings of the interview become supporting evidence to detect the reasons that have contributed to misconceptions among students.

Textbooks that are used as references often inevitably lead to inconsistencies in students, there are a variety of misconceptions in textbooks, even in the conceptual aspect, there is a misconception of passive transport; the aspect of showing an osmosis image, there is no caption, there is no image that describes co-transport and exocytosis; elements of the usage of language with regard to the definition of turgid may be clarified.

Factors that led to misconceptions experienced by students were obtained through the student interviews listed in Table 4 and the biology teacher interviews in

Table 5. Based on the interview, there were six causal factors, particularly regarding students themselves, learning methods, teaching methods, learning media, teaching materials in the form of a book, and context.

The response to the results of student interviews shows that students are not good at and are not quick to understand the concept. Misconceptions are influenced by students' cognitive abilities, and misconceptions are often experienced by students who are at a low cognitive level because concepts are difficult for students to understand (Luciana, 2017).

Students' textbooks also triggers misconceptions in students. Based on the students' responses and the evaluation of the textbooks, it shows that there are concepts that have not been identified and that there are a number of misconceptions. Textbooks that do not include a concept cause students to seek information from other sources that are not entirely accurate with expert concepts (Purwanti & Kuntjoro, 2020).

The findings of the teacher's interview were based on the method of discussion, lectures, and experiments, but the results of the student interview said that they had never conducted an experiment. According to Hermawati (2012), the learning process using the teaching method helps to generate learning activities that are only memorizing and accepting.

Learning media and teacher's methods will also create misconceptions in students. Based on the student's comments on the outcomes of the interviews, it is seen that the instructional media have never been used by the teacher to provide membrane transport material. The teacher also provides the material briefly to such an extent that students can get a bit of information about membrane transport. Teachers are one of the reasons that play an important role in the misconceptions faced by students (Chanariosi, 2014). The teacher thinks the explanation of the content is straightforward but also encourages students to encounter misconceptions.

Context is also a source of misconception. Based on the student's statements, it can be seen that the concept of membrane transport gained by students is not just from the internet, students' textbook, and teacher interpretations, but also conversations with other students or others. Discussion is an occurrence that has a propensity for students to experience misconceptions (Chanariosi, 2014). If there are errors made by other students who are asked to discuss it, it can trigger misconceptions (Suparno, 2013).

CONCLUSION AND SUGGESTION

Conclusion

The misconception profile of students in membrane transport sub materials showed that students who understand the concept, do not understand the concept, and have encountered misconceptions were 9,625%, 31,250%, and 59,125% respectively. Factors that affect the misconceptions faced by students were teacher, teaching method, learning media, students' textbooks, and including students themselves.

Suggestion

Researchers provide the following suggestions to minimize any misconceptions in students, namely:

1. Teachers are encouraged to analyze the learning strategies used in educational materials with the intention that concepts taught can be grasped by students, for example, teachers can use guided inquiry learning model, so not only by instruction and discussion approaches. In addition, teachers can provide some simple practicum about membrane transport. For example, the medium for teaching diffusion is by dropping colored powder into water or spraying perfume to a certain point in the room. The medium for teaching osmosis, the teacher can use potato and sugar solution, etc.
2. Other researchers are encouraged to research on the profile of students' misconceptions in order to improve the test tools used by providing an option of explanations for students reacting to the level of confidence at the fourth level in order to reinforce the root of the reasons why students chose the answer alternatives at the first and second level.

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