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Misconceptions identification on biodiversity and protist using multiple-choice open reason (mcor)

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ABSTRACT

This research aims to identify misconceptions of Biodiversity and Protist topics The type of the research was a quantitative descriptive study. The sampling technique was done by purposive sampling with the provisions that misconceptions have not been identified, and students have received Biodiversity and Protists. The object of the research was the students of class XI Senior High School (SMA) of Islam Malang, SMAN 1 Trenggalek, MAN 2 Lamongan, and SMAN 1 Pare, each in one class with a total of 127 students. Retrieval of data using a diagnostic instrument in the form of multiple-choice open reason (MCOR) with a total of 15 questions about Biodiversity and 15 questions about Protist. The results showed the average of misconceptions was 22,08% experienced by students on Biodiversity and the mean of misconceptions of 13,25% experienced by students on Protist. The highest misconception occurred in the threat indicator of biodiversity damage that was equal to 35,91%. Whereas for Protist, the highest misconception occurred in the sub-indicator identification of the general characteristics of Protist like an animal that was 26,28%. In conclussion, the misconception on the material of Biodiversity and Protist, including misconception type 2 or Mi-2, which was, students answer incorrectly to the core questions and accompanied by the right reasons. A suggestion from the research that has been done is the necessity to develop a level three diagnostic instrument used by experts to find out students' misconceptions so that the results could be more detailed. Besides, it is necessary to identify the causes of misconceptions and identify misconceptions in student handbooks on Biodiversity and Protist.

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INTRODUCTION

Learning is an attempt to gain knowledge that can change the behavior or response caused by the effort made. In Indonesia, the 2013 curriculum has been the learning process experienced by students to gain knowledge, improve skills and attitudes (Permendikbud, 2018). In the aspect of knowledge, students construct knowledge from their cognitive experiences when interacting with the environment in the learning process (Duit & Treagust, 2003; Sari, 2013). Students construct knowledge through their interactions with objects, phenomena, experiences, and the surrounding environment (Tytler, 2002). The process of receiving knowledge is the adjustment of new concepts and ideas with the frame of mind already existed in students (Tan, Taber, Goh & Chia, 2005). Students who have accepted and understood the concept can apply the concept to daily life (Johnstone, 1991; Gabel, 1999).

However, students can construct erroneous knowledge because concepts are mixed with ideas and other ideas. The philosopher of social constructivism states that concept errors received by students are wrong because they have no scientific framework that can be used as a reference for the process of assimilation of concepts (Rustaman, 2005; Suparno, 2005). Students' conceptions that differ from the concepts of scientists are called misconceptions (Treagust, 1988; Anderson, 2007). Misconceptions arise because students' pre-knowledge is not following scientific thinking, and the concepts obtained tend to be based on feelings (commonsense) (Bahar, 2003; Nurulwati, Veloo & Ali, 2014). Factors causing misconceptions are students, teachers, teaching materials, context, and methods (Tekkaya, 2002; Suparno, 2005; Imaningtyas, Karyanto, Nurmiyati & Asriani, 2016).

Students maintain misconceptions throughout learning activities at school unless they are corrected on time (Driver, Squires, Rusthworth & Wood-Robinson, 1994; Suwarto, 2013; Putri & Harahap, 2016). Before it is corrected, misconceptions are identified to develop appropriate strategies so that misconceptions can be corrected. The method used to identify misconceptions is the presentation of concept maps and interviews, diagnostic tests, and a combination of tests with clinical interviews (Tayubi, 2005; Murni, 2013; Bayuni, Sopandi & Sujana, 2018). One way that is used by experts to identify misconceptions is by using multiple-choice diagnostic instruments. This instrument is to measure the level of student understanding of the concepts of a material and as a tool to diagnose the causes of low student learning outcomes (Candrasegaran, David & Mauro, 2007; Akbar, 2013).

Biology subject is always related to daily life, so there are many preconceptions or pre-knowledge obtained by students before studying in school (Ibrahim, 2012; Keleş & Aydın, 2012; Handoko & Sipahutar, 2016). Based on observations made in May 2019 at SMA Islam Malang, SMA Panjura Malang and SMA Surya Buana Malang showed that students who study Biology subject experienced many misconceptions, especially on Biodiversity and Protist. Basic Competence 3.2 is analyzing various levels of biodiversity in Indonesia and its threats and conservation while Basic Competence 3.6 states that students should be able to group protists based on general characteristics of the class and link their roles in life (Permendikbud, 2018).

Based on the results of observations and interviews showed that misconceptions in the matter of Biodiversity listed on each species with the same prefix as oranges, roses, cats are gene-level Biodiversity. Misconceptions on the subject of Biodiversity occur as teachers tend to give the wrong experience without providing contextual examples around the students' lives. The teacher simplifies learning by conveying images from the internet so that simplification causes misconceptions among students (Imaningtyas et al., 2016). The implication is that the people less well know biodiversity in Indonesia of Indonesia so that environmental concern is low (Alikondra, 1987).

While the result of observations and interviews showed misconceptions occur in Protist such as the cause of malaria is a virus or bacteria and not one of the Protozoa species. Misconceptions on protists occur because there are many species studied that are microscopic so that students can only imagine or see from the pictures presented by the teacher or images from textbooks and the internet. Also, the material studied at Protist is too dense (Murni, 2013). The role of protists is beneficial and

detrimental to human life that should be known by students. If students' misconceptions about Biology are not resolved, it will have an impact on students, such as not being able to integrate learning outcomes with the surrounding environment (Sari, 2013). Based on the description above, research is needed to identify misconceptions about the material Biodiversity and Protists in class X students.

METHODS

Design of the Study

This type of research was quantitative descriptive research. Research using a modified design from Treagust. The sampling technique used was purposive sampling. Samples were taken with the proviso that the identification of misconceptions among students about biodiversity and protists had never been carried out. Also, the research sample were students who have studied Biodiversity and Protist.

Procedure

Research procedures to identify student misconceptions was multiple-choice open reason (MCOR) using the research stage in Treagust (1988). The research stages in Treagust are (1) defining content, (2) obtaining information, and (3) developing diagnostic tests. However, the research stage in Treagust is modified, which can be seen in Figure 1.

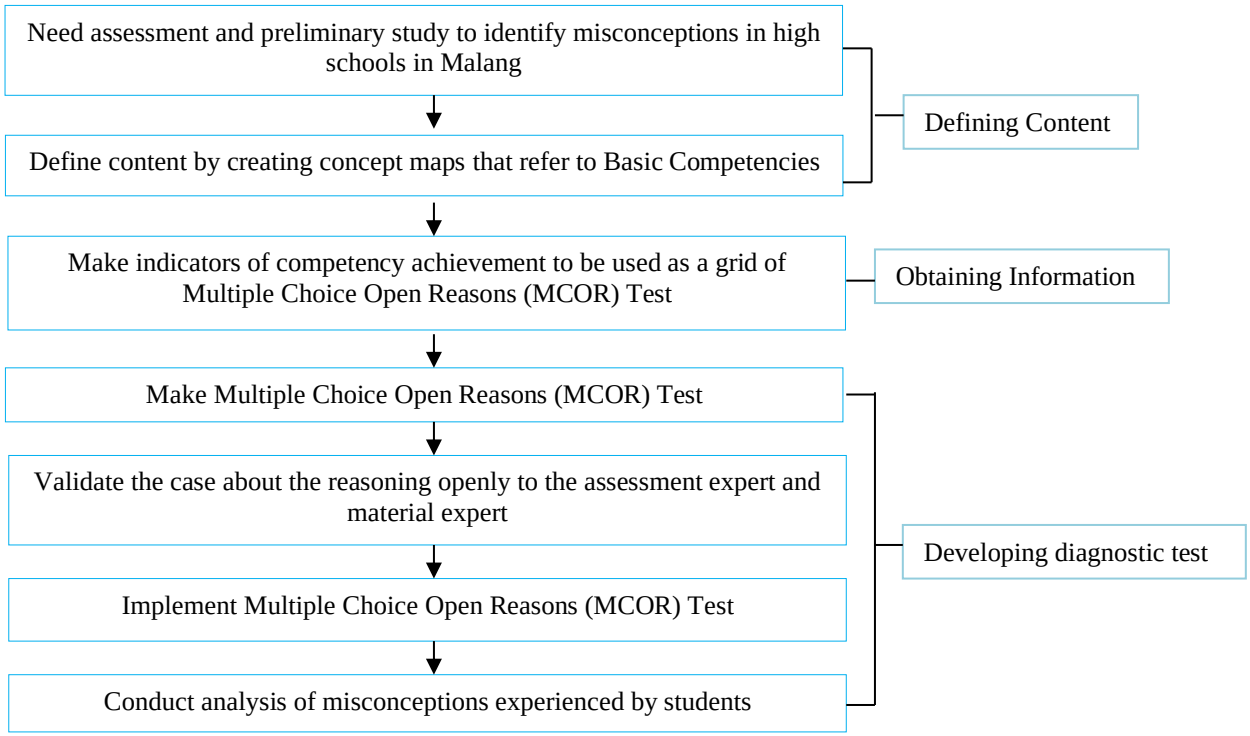


Figure 1. Research Procedure for Identifying Student Misconceptions that were modified from Treagust Step

Participant

Object of the research was class XI students in SMA Islam Malang with the number of 36, SMAN 1 Trenggalek with the number of 28, MAN 2 Lamongan with 32 students and SMAN 1 Pare with 31 students. The total number of research objects were 127 students, and the following presented data on the general student profile was listed in Table 1. The choice of class as a sample was done based on the recommendation from the supporting teacher. Also, based on students' heterogeneous abilities related to daily test scores. The study was conducted in July to August 2019.

Table 1
Student General Profile

Name of School	Class	Frequency of Gender	
		Male	Female
SMA Islam Malang	XI IPA 2	11	25
SMAN 1 Trenggalek	XI IPA 2	10	18
MAN 2 Lamongan	XI IPA 1	7	25
SMAN 1 Pare	XI IPA 3	7	24
Total		35	92

Instrument

Data collection used a diagnostic instrument in the form of multiple-choice open reason (MCOR) with 15 items on Biodiversity and 15 items on Protist. The compilation of the questions grid refers to the Basic Competency and Competency Achievement Indicators, according to Table 2.

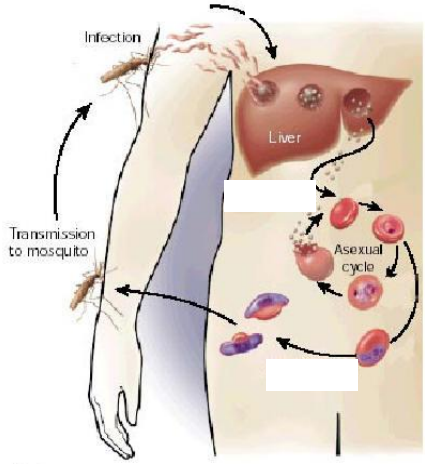
Table 2
Core Competency, Basic Competence, and Competency Achievement Indicators

Core Competence	Basic Competence	Competency Achievement Indicators
Understanding, applying, and analyzing factual, conceptual, procedural, and metacognitive knowledge based on his curiosity about science, technology, art, culture, and humanities with human, national, state, and civilization insights related to the causes of phenomena and events, and applying knowledge procedures in a specific field of study in accordance with their talents and interests to solve problems.	3.2 is analyzing various levels of biodiversity in Indonesia and its threats and conservation.	3.2.1 Analyze various levels of biodiversity in Indonesia. 3.2.2 Analyze the benefits of various levels of biodiversity in Indonesia. 3.2.3 Analyze threats to biodiversity damage at the level of genes, species, and ecosystems. 3.2.4 Analyze the conservation of biodiversity at the level of genes, species, and ecosystems.
	3.6 states that students can group protists based on general characteristics of the class and link their roles in life	3.6.1 Identify the general characteristics of protists like an animal. 3.6.2 Identify the general characteristics of protists like a plant. 3.6.3 Identify the general characteristics of protists like fungi. 3.6.4 Grouping protists like an animal, protists like plant and protists like fungi based on observed characteristics. 3.6.5 Analyzing the role of protists in daily life.

(Permendikbud, 2018)

Essential Competencies revealed several indicators of competencies' achievement that were used as a reference for the distribution of the proportion of questions. Indicators of achieving competency on biodiversity and protist can be seen in Table 2. Based on the indicators that have been compiled, then the question grid was made. The indicators and lattice questions were validated with the material expert and the assessment expert. Examples of MCOR diagnostic instruments on biodiversity and protist can be seen in Table 3.

Table 3
Example of MCOR Diagnostic Instrument on Biodiversity and Protist

Basic Competence	Competency Achievement Indicators	Problem Indicator	Questions	Answer Key
3.2 is analyzing various levels of biodiversity in Indonesia and its threats and conservation.	3.2.1 Analyze various levels of biodiversity in Indonesia.	3.2.1.1 Analyze biodiversity in type level by distinguishing two organisms.	In the picture below, coconut, sugar palm, areca nut, and palm plants show diversity at the...  a. Genes b. Type c. Class d. Population e. The ecosystem What is the reason you chose the answer above?	B
3.6 states that students can group protists based on general characteristics of the class and link their roles in life	3.6.5 Analyzing the role of protists in daily life.	3.6.5.4 Analyzing the role of an adverse protist like an animal, namely *Plasmodium vivax*, the cause of malaria by providing images that analyze the oocyst life cycle.	Look at the picture below!  To study *Plasmodium vivax* oocysts, we must make observations on... a. Erythrocytes infected with malaria b. Blood plasma of sick people malaria *c*. Mosquito intestinal wall containing *Plasmodium vivax* d. Mosquito salivary glands that contain *Plasmodium vivax* e. Blood in the gut of a mosquito that contains *Plasmodium vivax* What is the reason you chose the answer above?	C

The results of the validation by the material experts in the form of suggestions and comments that need to be revised in questions number 3, 6, 8, and 11 related to the choice of answers that are less homogeneous about the Biodiversity, while the protist needs to be revised in questions number 16, 18, 19 and 20 related to the question editor that can make students misconceptions when reading it. The results of the validation by the assessment expert in the form of suggestions and comments are to note the difference in typing "in" as a preposition that must be typed separately from the last word. The suffix "in" as a passive prefix that must be typed into one with the last word (see questions number 20, 29, and 30). Typing words for the validation questionnaire must also be by PUEBI. The word "reason" should be replaced by the statement "What is the reason you chose the answer above?".

Use a shorter sentence for question number 24. The next step is to make improvements according to the suggestions and comments of the validators. After that, conducting a multiple choice question test, the reasons are open to students to identify misconceptions.

Data Analysis

The analysis was done in a descriptive quantitative way to determine the percentage and category of students' level of understanding with possible patterns that can be seen in Table 4.

Table 4
Possible Patterns of Student Answers and Categories

Student Answer Pattern	Understanding Categories
The core answer of the test is true - the reasons are true	Understand (M)
The core answer of the test is true - the reasons are false	Misconception (Mi-1)
The core answer of the test is false - the reasons are true	Misconception(Mi-2)
The core answer of the test is false - the reasons are false	Do Not Understand(TM-1)
The core answer of the test is false - the reasons are not filled	Do Not Understand(TM-2)
The core answer of the test is true - the reasons are not filled	Understanding Partially Without Misconception (MS-1)
Not answering the core of the test and reasons are not filled	Do Not Understand(TM-3)

(Salirawati, 2011)

RESULTS AND DISCUSSION

The results of the study can be seen in Table 5 for Biodiversity and Table 6 for Protist. Based on Table 2, it can be seen that the highest average related to understanding the concept of Biodiversity is students experiencing misconceptions as indicated by the percentage of 22,08%, the average percentage of students who understand the concept was 19,90%, the average percentage of students who did not understand the concept was 11,96% and the average percentage of students who understood the concept in part by 0,05%. The highest percentage of misconception was found in the sub-indicator of biodiversity damage threat with a percentage of 35,91%.

Table 5
Results of Identification of the Understanding of the Concept of Biodiversity of Students

Indicator	Number of Questions	Understand %	Misconception		Don't Understand			Partial Understand %
			Type 1 %	Type 2 %	Type 1 %	Type 2 %	Type 3 %	
Analysis of Biodiversity Levels	1, 2, 3, 4, 5	21,51	9,41	31,07	28,03	8,89	1,09	0,00
Threat of Biodiversity Damage	6, 7, 9, 10, 11	14,21	10,37	35,91	27,38	10,28	1,85	0,00
Diversity Conservation Efforts	8, 12, 13, 14, 15	23,99	20,16	25,54	20,97	6,11	3,07	0,16
Average %		**19,90**	**22,08**		**11,96**			**0,05**

Based on Table 3, it shows that students who understand the concept have an average percentage of 6,15%, the average percentage of students who experience misconceptions was 13,25%, the average student who does not understand the concept was 16,55% and the average percentage of students who understand some concepts was 1,37% in Protist. The highest percentage of misconception was found in the Sub-indicator Identification of General Characteristics of Protists like Animal at 26,28%.

Table 6
Results of Identification of the Understanding of the Protist Concept of Students

Indicator	Number of Questions	Understand %	Misconception		Don't Understand			Partial Understand %
			Type 1 %	Type 2 %	Type 1 %	Type 2 %	Type 3 %	
Identification of General Characteristics of Protists like Animal	16, 17	19,07	26,28	11,32	5,91	28,81	8,62	0,00
Identification of General Characteristics of Protists like Plant	18, 19	0,35	1,79	23,02	8,47	46,52	13,22	0,00
Identification of General Characteristics of Protists like Fungi	20, 21	0,45	6,26	18,58	10,48	35,60	2,46	1,17
Classification of Protists like Animal, Protists like Plant and Protists like Fungi	22, 23	7,77	9,21	12,29	5,33	35,10	2,96	2,34
Role Protists	24, 25, 26, 27, 28, 29, 30	3,12	3,85	19,92	6,22	34,31	4,23	3,35
Average %		**6,15**	**13,25**		**16,55**			**1,37**

Based on the results of research on the identification of biodiversity misconceptions that can be seen in Table 2, the highest average 22,08% of students experience misconceptions. Students experiencing misconceptions mostly on type 2 (Mi-2), which was giving the core answer to the wrong test. However, the reason was correct than students who experienced misconceptions on type 1 (Mi-1), namely the core answer of the text was correct, but the reason was wrong. In the biodiversity level analysis indicator, students are presented to be able to analyze the biodiversity level of genes, types, and ecosystems. However, students experienced type 1 (Mi-1) misconceptions of 9,41% while type 2 (Mi-2) misconceptions amounted to 31,07%. Students answer core questions with wrong answers, and most students cannot distinguish between levels of biodiversity. Students were confused about determining the level of biodiversity, namely the level of genes, types, and ecosystems. However, most students give the right reasons. The reason of students were right as to diversity can be seen from anatomical differences. Student answers were wrong, and the reasons were correct, as well as students' answers were correct, but the reasons were wrong can lead to misconceptions about students. Misconceptions on students are caused by not understanding the concept well or only understanding some of the concepts (Caleon & Subramaniam, 2010).

Based on observations of classroom learning and interviews with teachers and students, the cause of misconceptions at the level of Biodiversity is that teachers tend to ask students to read textbooks that contain examples of biodiversity differences in general, and the information contained in textbooks is outdated and not contextual. Also, the teacher does not do the practicum by making small observations in the school environment to determine the differences in species at various levels of Biodiversity. Observations in the school environment can enhance contextual learning to form meaningful learning, and students do not learn by rote. The cause of misconception at the level of Biodiversity is in accordance with statements from Septian, Ariyati & Marlina (2018) that students' assumption that Biodiversity is at the level of color differences, sample variations to distinguish various levels of Biodiversity are less extensive and do not relate to contextual conditions, students understand Biodiversity at the ecosystem level is where living things live.

Misconceptions experienced by students as many as 10,37%, including type 1 misconceptions and 35,91%, including type 2 misconceptions on the threat indicator of biodiversity damage that is

happening. Students are given questions to analyze the threat of damage to Biodiversity. However, most students were wrong in determining the main answer and correct in making an excuse. This indicates a misconception in students because students only understand some concepts. Students do not fully understand the concept of various factors that can threaten biodiversity damage. The leading cause of misconceptions about the threat of biodiversity damage is the lack of emphasis given to the context of circumstances surrounding students so that students tend to have an attitude of not caring about the environment and not looking for the root causes of the threat of damage (Makki, Abd-El-Khalick & BouJaoude, 2003; Sari, 2007). Learning does not integrate the latest natural state information with the threat of biodiversity damage, and the teacher only focuses on the information and examples in the textbook (Lambi, 2009).

Indicators of biodiversity conservation efforts showed that as many as 20,16% of students experience misconceptions (Mi-1), and 25,54% of students experience misconceptions (Mi-2). The questions given to students aim to find out students' understanding of biodiversity conservation efforts. Misconception shows that students are not able to analyze various kinds of biodiversity conservation efforts. Students are less critical and creative in determining preservation efforts as seen from internet brochures and reading books while learning to find preservation efforts. The internet and textbooks tend to show information that has already been done, so critical and creative thinking is needed to come up with ideas for conservation (Kollmuss & Agyeman, 2002). The wrong concept that is owned by students makes the level of concern for the environment low due to not being integrated with students' daily lives and not being able to provide solutions or efforts to conserve nature (Pooley & O'Connor, 2000)

The results showed the mean of students who misconceptions about Protist of 13,25% and students who did not understand the concept of 16,55%. Indicator of the identification of general characteristics of protists like an animal, students experienced a misconception of 26,28% in type 1 (Mi-1), and 11,32% occurred in type 2 misconception (Mi-2). Indicator identification of the general characteristics of protists, like plant showed 1,79% of students experiencing misconceptions (Mi-1) and 23,02% of students experiencing like protists like fungi, misconception of type 1 students (Mi-1) was 6,26% and misconceptions of type 2 students (Mi-2) were 18,58%. Most students answer wrong but give the right reasons. This pattern of misconception shows that students are still confused about identifying protists based on the characteristics they have. Students tend to learn to memorize the characteristics of protists and do not understand them fully. Some difficulties to study Protist are to know the scientific name of Protist species, to give an example of Protist, to recognize the general characteristics and unique characteristics of protist like animal, protist like plant protists like fungi, in memorizing terms contained in the material, and difficulty in recognizing microscopic objects of protists (Ariyanto, 2012; Zunitasari, Hidayati & Triatmanto, 2016). Students tend not to understand the characteristics of each group on plant-like protists, in memorizing the terms contained in the material, students have difficulty in distinguishing the form of motion equipment owned by each phylum in protists like animal, and students do not understand the life cycle concept of protists like fungi (Mukaromah, Siti & Ibnul, 2012; Raharjo, Ramli & Rinanto, 2018; Riki, Ningsih & Yeni, 2018).

Students experienced type 1 (Mi-1) misconceptions of 9,21% and type 2 (Mi-2) misconceptions of 12,29% on indicators of protist classification like to animals, plants, and fungi. Misconceptions on this indicator because students do not understand the Protist being studied. Students tend to identify features through images on the internet rather than through direct observation. This causes students not to hold concepts correctly and only imagine or visualize objects through images. Learning by only giving pictures without direct observation and not accompanied by the teacher can cause misconceptions on students (Gurel, Eryılmaz, & McDermott, 2015). Causes of misconception in the classification of protists include the difficulty in grouping protists based on observable characteristics, not understanding the basis for classifying protists (Dewi, 2009; Riki et al., 2018).

While the indicator of the role of protists, students experience type 1 misconceptions (Mi-1) of 3,85% and type 2 misconceptions (Mi-2) of 19,92%. Students answer wrong but give the right

reasons. This is due; students learn the role of protists only from textbooks and the internet. The teacher does not reinforce by integrating it into daily life. As a result, students do not hold the correct concept of the role of protists. Students claim to only learn by memorizing when the exam will be held. Misconceptions due to students conceptually do not master the material being studied as a whole, the level of mastery of the material is very low, the basic concepts are not mastered, even not only the problematic parts that are not understood, maybe also the parts that are moderate and easily cannot be adequately mastered (Mulyadi, 2010). Students do not understand the concept and only memorize the concept of the role of protists and species that are beneficial or detrimental (Zunitasari *et al*., 2016). The role of protists is very much beneficial or detrimental because the distribution of protists is comprehensive (Foissner, 2007).

CONCLUSION

The results of the study can be concluded that the misconception of Biodiversity in class X students showed the highest mean of 22,08% while the average of students experiencing misconception of Protist was 13,25%. Students experience type 2 (Mi-2) misconceptions that are answering core questions wrong, but the reasons are given for correct answer choices. The highest percentage of students experiencing misconceptions was 35,91%, which occurred in the Biodiversity damage sub-indicator, and 26,28% occurred in the sub-identification of general characteristics of protists like an animal. The results of the identification of misconceptions on indicators of biodiversity and protist can be used as a reference to improve misconceptions in students. In delivering Biodiversity and Protist, teachers are expected to use appropriate models, methods, and media, to reduce or prevent misconceptions among students. Further research can be done developing diagnostic instruments three-tier used by experts to find out students' misconceptions in more detail.

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