Analysis of Students' Misconceptions Using Three Tier-Test Multiple Choice on Ecosystem Material in SMA

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Article Info

Abstract

This study aims to analyze high school students' misconceptions using a three-tier multiple-choice test on Ecosystem material. The study was conducted SMA Negeri 1 Bawang in the odd semester of the 2020/2021 school year. This research is quantitative descriptive with a sequential explanatory research design. The purposive sampling technique was used to take the research sample. The sample in this study were students in class XI MIPA 1, XI MIPA 2, and XI MIPA 6 SMA Negeri 1 Bawang, with 92 students. The researcher used a three-tier multiple-choice test instrument to analyze SMA Negeri 1 Bawang students' misconceptions on the Ecosystem material by exploring the combination patterns in the students' answers. The results showed that students who experienced misconceptions in the Ecosystem material at SMA Negeri 1 Bawang were 41.16%, categorized as medium. The highest student misconception occurred on Dynamics and Population Density at 70.65% in the medium category. In comparison, the lowest misconception happened in the Food Chain Cases by 25% in the low class. In general, the causes of student misconceptions are students' preconceptions, lack of literature, and lack of time in learning. This research concludes that the three-tier test multiple choice instrument is feasible and practical to analyze students' misconceptions on Ecosystem material.

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INTRODUCTION

Each concept of science does not stand alone, but every idea is related to one another. All the existing images form a kind of network of knowledge in mind. Often students only memorize concept definitions without paying attention to the relationship between one concept and another. Thus, the new idea does not enter the network of images that already exist in students' minds. Still, the concept stands alone without the relationship between concepts often leads to misconceptions.

Before students take lessons that teachers guide, students must have initial conceptions or preconceptions. However, from the initial concept, some contain misconceptions or misconceptions. Usually, this preconception is obtained from parents, friends, early school, and experiences in students' environment. The misconception is because this initial knowledge is obtained from different backgrounds and sources of inaccurate information, even though one's mastery of initial knowledge greatly influences the acquisition of knowledge in schools (Pinker, 2003; Wahyuningsih, et al., 2013).

The misconception understands the material/concept that is not by the experts' scientific knowledge or experience. Misunderstandings can be measured through diagnostic tests. One form of a diagnostic test is the Three tier-test multiple-choice (3TMC). It consists of three parts. The first part contains questions that contain various answer choices. The second part includes reasons that refer to the answers in the early part. The third part consists of the confidence students' level in answering the first level, and the second level with a choice of responses in the form of sure and not sure. Multiple choice diagnostic tests help identify misconceptions because they are comfortable, economical, and time-consuming to implement. The three-level multiple-choice type diagnostic test used is a form of refinement of the primitive state of the one-level multiple-choice diagnostic test (Pesman, 2010; Suparno, 2013; Taslidere, 2015).

The Ministry of Education and Culture released the 2018 PISA survey results, which showed a decrease in the quality ranking of Indonesian education. Banjarnegara Regency is one of the districts in Central Java Province. The National Examination results at the district level with the ecosystem and ecological indicators showed that the results of the data on the absorption value of students were less than the standard limit, namely 44.46%. Furthermore, it is related to the plan of research in SMA Negeri 1 Bawang, showing the results of the data on the value of the absorption of students by 55.26%.

Based on the background of the problem stated, an analysis of biological misconceptions will be carried out with a three tier-test multiple-choice to identify and identify high school students' misconceptions on Ecosystem material.

METHODS

The researcher conducted the study at SMA Negeri 1 Bawang in the odd semester of the 2020/2021 academic year in December 2020. Data collection was based on specific considerations, namely based on the research subjects' conditions most likely to be asked for full information. The population includes all grade of XI MIPA students. Sampling using a purposive sampling technique. The samples to be used were students of class XI MIPA 1 (31 students), XI MIPA 2 (31 students), and XI MIPA 6 (30 students). Sequential explanatory was used as research design (Mulyadi, 2011; Sugiyono 2014).

This study's data collection methods include written test results on students, results of interviews with teachers, and questionnaires to students. The analysis of misconceptions used in the analyzer is in the form of a developed Microsoft Excel program. Based on the data obtained, it can be seen that the criteria for understanding the students through the percentage of students who understand concepts, misconceptions, do not understand concepts, guess, and do not understand concepts (Fransiska, et al., 2018). After categorizing the test results and calculating the percentage of students who experience misconceptions, then criticize the misconceptions based on low, medium, and high criteria (Kurniawan & Suhandi, 2015).

RESULTS AND DISCUSSIONS

Student Misconception Profile

The researcher used the three-tier multiple-choice diagnostic question instrument to analyze students' misconceptions. This test instrument consists of 30 items given to students after receiving learning material on Ecosystems. A diagram of the recapitulation of the results of students' misconceptions can be presented in Figure 1.
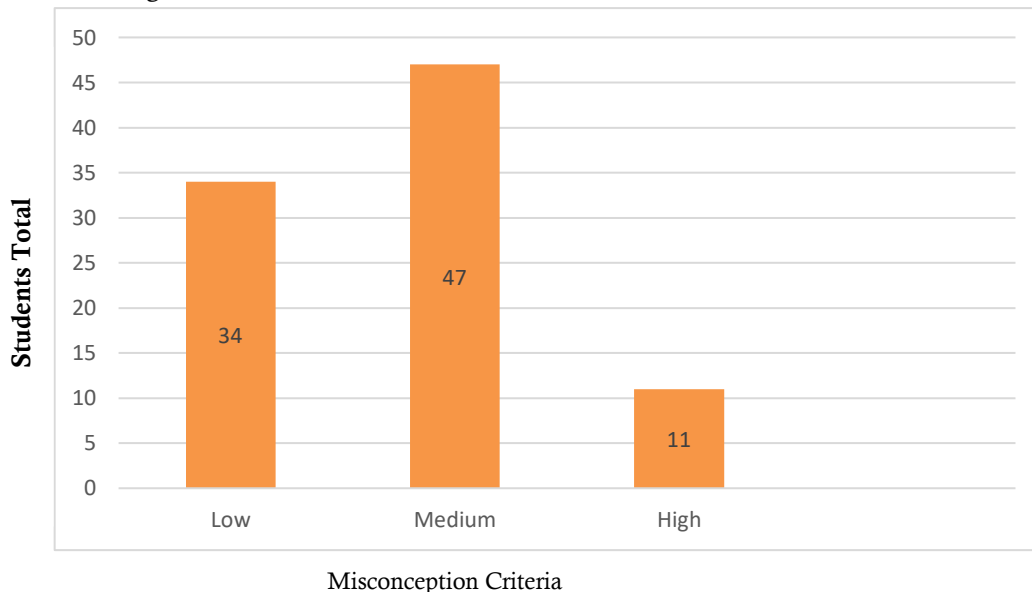

Figure 1 Recapitulation Diagram of Misconceptions Results

Based on the analysis of students' misconceptions on the diagram presented in Figure 1, the X-axis is the criteria for students' misconceptions, namely low, medium, and high, while on the Y-axis number. The 92 students who worked on the three-tier multiple-choice diagnostic questions to identify misconceptions based on the graphic diagram. It consisted of 11 students who experienced misconceptions in the high category, 47 students who participated in medium category misconceptions, and 34 students who participated in low category misconceptions. From the table of misconception criteria, if the percentage of students who experience misconception is less than 30%, it can be categorized as a low level of misconception, a portion of more than 31% is in the medium category level, and a rate of more than 71% is categorized as a high level of misconception (Kurniawan and Suhandi, 2015). Overall, the misconceptions that occurred in grade XI students about the Ecosystem material in SMA Negeri 1 Bawang were 41.16%, with the moderate misconception category.

The misconception of Question Items

Each indicator of concept understanding will be represented by several item numbers based on temporal indicators. Analysis of misconceptions based on the achievement of the item indicators in each research class. Misconception profiles were also analyzed for each diagnostic item. The results of the misconception analysis of the things are presented in Table 1.

Table 1 Results of the Analysis of Question Items Misconception

Problem Indicators	Item	Percentage of	Misconception

	Questions	Misconceptions (%)	Criteria
Students can solve problems on the dynamics and density of biotic populations	1	70,65	Medium
	2	34,78	Medium
Students can analyze the habitat formation of biotic and abiotic components	3	35,87	Medium
Students can express the nature of living things based on how to obtain food	4	42,39	Medium
	5	34,78	Medium
Students can solve problems in the food chain	6	30,43	Low
	7	60,86	Medium
Students can analyze problems that have an impact on the food chain	8	34,78	Medium
	9	25	Low
Students can conclude events related to trophic level	10	57,61	Medium
Students can analyze events related to trophic level	11	30,43	Low
	12	39,13	Medium
Students can link forms of interaction between populations	13	32,61	Medium
	14	29,35	Low
Students can analyze forms of interaction between populations	15	41,30	Medium
Students can analyze the interaction relationship between trophic levels in the ecosystem in creating food webs	16	47,83	Medium
	17	68,48	Medium
	18	40,22	Medium
Students can solve the problem of the impact of changes in one biotic component on other biotic components	19	42,39	Medium
	20	34,78	Medium
Students can analyze the impact of changes in one biotic component on other biotic components	21	44,56	Medium
Students can analyze the flow of material on the food chain	22	47,83	Medium
	23	40,22	Medium
Students can analyze ecological pyramids and the ability to store energy between trophic levels	24	33,69	Medium
	25	31,52	Medium
Students can explain the stages in the biogeochemical cycle	26	44,56	Medium
	27	41,30	Medium
	28	28,26	Low
Students can analyze the stages in the biogeochemical cycle	29	51,09	Medium
Students can predict the causes of problems in the biogeochemical cycle	30	40,22	Medium

The categories of misconceptions consist of three, namely low, medium, and high. Based on the analysis of question item misconceptions, the indicator with the highest percentage of misconception answers was Medium misconception category, namely question number one with material dynamics and population density of 70.65%. The lowest misconception percentage with low misconception category is question number nine with food chain material by 25%. Based on the overall questions, the results can be obtained as many as 25 questions answered in the Medium misconception category. There were five questions answered with the low misconception category.

Sources of Answers to Students' Misconceptions

Based on the results of students 'answers, there is data about the sources of answers to students' misconceptions to make it easier to determine the causes of misconceptions that occur in students. Table 2 presented the analysis of the origins of answers to students' misconception.

Table 2 Results of the Analysis of the Answers to Students' Misconceptions

Item Questions	Source of Answers					Number of Students Who Have Misconceptions
	A	B	C	D	E	
1	6	17	9	6	27	65
2	2	9	2	10	9	32
3	3	6	0	5	19	33

No	A	B	C	D	E	Total
4	4	11	5	6	13	39
5	3	6	1	11	11	32
6	8	7	4	2	7	28
7	6	15	7	8	20	56
8	3	10	4	2	13	32
9	2	7	4	1	9	23
10	2	18	5	13	20	53
11	6	10	3	6	3	28
12	1	16	2	6	11	36
13	4	6	2	5	13	30
14	5	8	3	2	9	27
15	2	13	3	1	19	38
16	9	8	8	8	11	44
17	10	14	12	9	18	63
18	6	9	5	8	9	37
19	4	7	3	8	17	39
20	3	9	6	4	10	32
21	9	9	7	5	11	41
22	8	14	5	10	7	44
23	3	9	7	5	13	37
24	5	11	4	5	6	31
25	2	12	2	5	8	29
26	3	9	3	9	17	41
27	4	11	7	3	13	38
28	2	5	0	10	9	26
29	4	11	3	10	19	47
30	3	8	6	4	16	37

Information:
A: Teacher's explanation
B: Personal experience
C: Have Seen Similar Events
D: Biology Textbook of Intan Pariwara Grade X
E: Internet

The number of students who experienced misconceptions was mostly at number 1, which was 65 students. The source of the answers of students who participated the most misconceptions got answers from various sources. The largest source of solutions used in answering question number 1 was the internet with 27 students who responded to questions because they knew material from the internet. Students who experienced the lowest misconception were number 9, which was 23 students. The largest source of answers used in answering question number 9 is the internet with nine students who responded to questions because they knew material from the internet.

Facilities that Support the Learning Process of Students

The teacher, as a facilitator plays a crucial role in learning. Learning is required to be active in the learning process or student learning center, but that does not mean that teachers do not have a role in-class learning. Misconceptions that occur in XI grade students of Ecosystem material at SMA Negeri 1 Bawang are included in the Medium category's misconception. Even though it is still classified as a Medium criterion, misconceptions must always be minimized because it will harm students. Factors supporting the learning process are essential things to know to find the right solution. Therefore, a facility questionnaire that helps the learning process carried out by students is made. Table 3 presented the results of the facility questionnaire analysis that support the learning process of students.

Table 3 Results of the Facility Questionnaire Analysis that Supports the Learning Process of Students

Questions	Yes	No
The school provides a sound school library, and there is more than one learning	54	0

resource about ecosystem materials		
Classrooms are clean and comfortable so that they support the learning process	52	2
The internet network is stable and smooth so that access to material information is easy to obtain	47	7
Teachers and students actively question and answer if there is material on the ecosystem that does not understand	54	0
The teacher shows videos related to ecosystem materials	38	16
The teacher explains the ecosystem material using PowerPoint media	34	20
The teacher gives an LDS (Student Discussion Sheet) assignment on ecosystem material to work on for each group	51	3

Overall, the misconceptions that occurred in class XI students about the Ecosystem material in SMA Negeri 1 Bawang were 41.16% with the Medium misconception category. This percentage is obtained from the total number of answers to misconceptions, divided by the number of students' responses multiplied by 100%. This research class was previously selected using a purposive sampling technique. According to Sugiyono (2014), purposive sampling is a data source sampling technique with specific considerations by the teacher, namely based on the test scores of students in the previous semester. According to the teacher at SMA Negeri 1 Bawang from the three classes, it is a good class following the learning process and can be said to be a superior class because it has high grades. Courses with high scores should have a low misconception level, but this does not prove that only types have low misconceptions.

Based on the analysis of students' answers, the misconceptions of class XI students at SMA Negeri 1 Bawang on the Ecosystem material were included in the Medium category. Based on table 1, most misconceptions occur in number 1, with a percentage of 70.65% misconceptions with Medium misconceptions criteria. The lowest misconception happens in number 9 with a rate of 25% misconceptions entering into low misconception criteria.

The question indicator used for number 1 is about population dynamics and density of biotic populations with question level C3. In item 1 asks students to determine the components used in calculating rabbit population density in the savanna ecosystem. After filling out the questionnaire and analyzing the answers, the misconceptions that occurred to students regarding item number 1 were (1) students assumed that to calculate population density, namely knowing the area occupied and the extent of the population to be calculated as a whole ecosystem area, (2)) students consider that the people of other living things is influential in calculating population density, (3) students only focus on the first level answer choices and ignore the option of reasons for answers found at level two, (4) students who experience misconceptions answer with source most of the solutions come from the internet and personal experience.

The students' assumptions are incorrect, because to calculate the population density, the components used are the number of rabbits (total population) per area occupied (Sulistyowati, et al., 2016). The use of the internet as a learning resource is a good thing if the sources used are valid sources.

The question indicator used in item number 9 analyzes problems that impact the food chain with the C4 item level. In item 9, students solve issues about the impact of tomcat extinction in the ecosystem. The percentage of misconceptions that occur is 25% with low misconception criteria. One of the requirements for conceptual understanding (PK) is at number 9, as many as 63.04% (58 students) already understand the concept of solving problems in the ecosystem. The misconceptions that occur in students regarding number 9 include (1) students assume that the impact of cats being mass-destroyed is that rice production decreases due to pest attacks. So that farmers replace the role of tomcats using insecticides that last longer and have good quality, (2) students only focus on the first level answer choices and ignore the option of reasons for answers found at level two, (3) students who experience misconceptions answer with source answers most of which come from the internet.

The students' assumptions are not correct. Students who already understand the concept (PK)

answer the question with a solution if tomcat is eradicated because it moves from rice fields to the neighborhood and causes problems. It can make rice production decrease due to planthopper attacks. The tomcats' move to the resident's housing made the planthopper pest population increase and could result in crop failure. Item 9 makes students analyze so that students are required to think critically and rely on the logic of students, so it would be better if students do not rely on the internet as a learning resource.

The most widely used source of answers used by students in answering questions is the internet source. When students answer the misconception that the source used is the internet, this also indicates that students spend more time learning via the internet. The internet is a broad medium, and there is a lot of reading, if students do not read carefully and do not choose reliable learning sources, this will lead to misconceptions. Also, many of the students experience misconceptions because they learn from personal experience.

The teacher learning model, in general, has implemented the 2013 Curriculum. Teachers are oriented towards students by giving questions independently with a few available explanations beforehand, so that students learn by themselves and get initial preconceptions based on their experiences. Students also only use one compulsory book, an Intan Pariwara printed package book containing material and practice questions. Other material that is not included in the text must be searched in other books or the internet. This process of searching for Ecosystem material causes initial assumptions that lead to misconceptions. According to Shui-Te, et al., (2018), misconceptions are intense and persistent, so it is tough to be corrected later by the teacher who then explains the existing material.

The three-tier test multiple-choice diagnostic question instrument is an instrument that is contextual and makes students think critically and analytically. However, there are several limitations to this study. Namely, the sample used is only 92 students due to the Covid-19 outbreak, making researchers experience difficulties in retrieval. Data even though the large number and the small number of samples affect the data results' validity. Research using similar themes can increase the number of pieces so that the data results are more valid. Besides, this research was conducted online due to the covid-19 outbreak. Consequences that the results of the data when taken online. When data were taken directly at school, there could be differences. Research preparation included ensuring students understood the provisions of answering three tier-test questions—multiple choices online via a google form.

Some of the limitations mentioned in this study are expected to be input for other researchers who want to use a similar theme so that further research can be carried out with a larger number of samples so that the data results become more valid.

CONCLUSION

Based on the results of data analysis and discussion of research results, it is concluded that the three tier-test multiple-choice diagnostic question instrument can be used to analyze the misconceptions of SMA Negeri 1 Bawang students on the Ecosystem material. It used an analysis of the combination pattern of the students' answers. The analysis results showed that the profile of students' misconceptions on Ecosystem material in SMA Negeri 1 Bawang was in the Medium category with a percentage of 41.16%. The highest student misconceptions occurred on Population Dynamics and Density with a ratio of 70.65% which could be categorized as Medium, Mediating the lowest misconception happened on the Food Chain topic with a rate of 25% which could be classified as low. In general, the causes of student misconceptions are students' preconceptions, lack of literature, and lack of time in learning.

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