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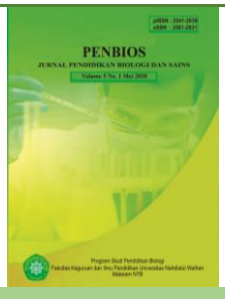

Review Article

Identification of Material Misconceptions in High School Biology Textbooks and Their Relationship with Students' Misconceptions

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ABSTRACT

The misconception is a concept that is different from the concept that has been agreed upon by experts. Misconceptions can cause students to understand concepts incorrectly. This study aims to identify misconceptions in high school biology textbooks and their relationship to misconceptions in students. This research is a meta-analysis with a literature review method on data sources in the form of articles in electronic journals. This study examines the results of the analysis of high school biology textbook misconceptions and student misconceptions from 15 relevant articles. Based on the results of this study, it is known that 12 high school biology textbooks have misconceptions with low, medium, and high misconception categories. The misconceptions contained in the textbooks are on average classified in the low to a medium category, but there are also textbook misconceptions that are included in the high category. The results of the analysis of students' misconceptions revealed that students experienced misconceptions in the medium to the high category of the 14 high school biology materials tested. Three common causes of misconceptions in students are misconceptions in textbooks, misconceptions in teachers, and misconceptions in students' initial concepts. Thus, it can be concluded that misconceptions in textbooks are one of the main causes of students' misconceptions, which results in students understanding the material incorrectly. This is evidenced by the fact that students experience misconceptions, especially on material that has misconceptions in textbooks.

INTRODUCTION

The learning process has components that are conditions for the learning process to occur. According to Pane and Dasopang (2017: 338), learning is seen as a process of interaction between learning components, namely teachers, students, learning materials, and learning resources.

Learning resources are one component of learning. There are various learning resources used to obtain information. One of the most frequently used learning resources is textbooks. Su`udiah, et al. (2016: 1744) states that textbooks are a source of learning in printed form. Generally, every level of education at various institutions uses textbooks as the main learning source in the learning process. The role of textbooks is very important as reference material in the learning process, so it is hoped that the textbooks in circulation are quality textbooks.

The quality of textbooks can be seen from various aspects. Mappiara and Munirah (2020: 2) state that the quality of textbooks can be seen from the aspect of content, aspects of the form of presentation, aspects of language use, and aspects of graphics. A good textbook is a textbook that is easy to understand and does not cause doubts for the reader when reading it. The fewer problems found in the textbook, the better the quality of the textbook. However, there are still problems in the textbook. Efendi (2011: 7) states the problems contained in textbooks are: (1) problems in the material aspect, including material in textbooks that is not proportional, there is a material that is not presented, the theory presented has errors, the integration of the material is weak, and the material is not complete, (2) aspects of material presentation, visible problems are the order that is not systematic and there are questions for which there are no answers in the book, (3) readability aspects, examples of problems that arise are the use of language and writing is still experiencing errors, not visible differences between materials with higher and lower levels of difficulty, and there are terms that are not explained in their meaning. These problems can result in the learning process not going well. This will have an impact on the learning objectives are not achieved optimally. Based on this statement, it can be seen how important the role of textbooks is, especially in biology subjects which have many concepts to learn.

One concept is continuous with another concept. Concepts are the building blocks of thinking. In solving problems, a student must know the relevant rules, and these rules are based on the concepts they have acquired (Puspitasari, et al. 2019: 172). Errors in understanding a concept will affect students in understanding other concepts and can cause confusion. Misconceptions are called misconceptions.

Misconceptions can be interpreted as meanings that are not in accordance with the concept, the application of an inappropriate concept, mixed concepts, and a hierarchical relationship between inappropriate concepts (Suparno, 2013: 4). Misconceptions also mean that the concepts presented are not in accordance with scientific concepts that have been approved by experts in their fields. According to Suparno (2013: 30), misconceptions can be caused by six factors, namely the constructivism philosophy angle factor, the student factor, the humanistic thinking factor, the wrong reasoning factor, the wrong intuition factor, and also the textbook factor.

Istighfarin (2015) states that misconceptions in both textbooks and students can be categorized into low misconceptions, moderate misconceptions, and high misconceptions. Categorized as low if the percentage of misconceptions ranged from 0%-30%, categorized as a medium if the misconceptions ranged from 31%-60%, and categorized as high if the misconceptions ranged from 61%-100%. Misconceptions with these various categories will cause various problems. According to Irani, et al. (2020), misconceptions will hinder the

process of acceptance and assimilation of new concepts so as to hinder student success. Misconceptions will cause wrong thoughts and views in understanding concepts so as to limit students in learning efforts and will hinder understanding and development between concepts that were previously studied and those that have been studied afterward (Puspitasari, et al., 2019: 172). If the misconception is not handled with the actual explanation of the concept by the teacher, then the student concerned will continue to use the wrong concept.

Based on an initial study of relevant articles, it can be seen that in high school biology textbooks there are still misconceptions with various percentages in each book, as well as students' misconceptions about high school biology material. For this reason, it is necessary to conduct an in-depth study to collect data regarding the misconceptions contained in high school biology textbooks and students' misconceptions on high school biology material and their causes, so that it is known the relationship between misconceptions in high school biology textbooks and students' misconceptions on high school biology material.

METHOD

This study uses a literature review method from various data sources in the form of relevant articles. The data sources that have been collected are processed in three stages, namely: (1) descriptive analysis, which is the stage of collecting data and analyzing data; (2) content analysis, which is the stage of drawing conclusions from the content of the source; (3) critical analysis, is the stage of criticizing the facts found from the sources used (Irani, et al., 2020: 349). Data was collected by the documentation method, namely the method of collecting data or extracting data from various data sources. In searching data sources, the keywords "Misconceptions of High School Biology Materials" and "Students' Misconceptions of High School Biology Materials" are used on the Google Scholar site. Then 15 articles were taken that conducted identification research on misconceptions in high school biology textbooks and analysis of students' misconceptions on high school biology material.

The results of the study were obtained from data sources in the relevant articles used, so the data used were in the form of secondary data, namely data that had been obtained from the results of previous research, not the results of direct observations. The data that has been collected is then arranged in tabular form, then reviewed and concluded, then presented again by the author with a qualitative descriptive method by interpreting the data and determining the relationship and views of the data. The qualitative descriptive analysis describes the conditions as they are in the data, without giving treatment to the variables studied, to obtain conclusions from the interpretation of the data. The analysis in this study was carried out by describing the material misconceptions in textbooks and material misconceptions in students. Then will be analyzed the causes of misconceptions in students. After the causes of misconceptions in students are known, reanalysis is carried out to determine the relationship between misconceptions in textbooks and material misconceptions in students.

RESULT AND DISCUSSION

The results obtained from the data that has been analyzed. The analysis step is carried out by

analyzing the percentage of misconceptions in textbooks, analyzing misconceptions in students, analyzing the causes of misconceptions in students, and analyzing the relationship between textbook misconceptions and students' misconceptions. The analysis of misconceptions in high school biology textbooks and students' misconceptions about high school biology material contained in 15 relevant articles are described as follows:

Table 3.1 Percentage of Material Misconceptions in Biology Textbook Class X

Textbook	Percentage of Misconceptions (%)	Material	Category	Source
A	11,10	Virus	Low	Saputri and Widyaningrum, (2016: 34)
B	21,05		Low	
C	31,03		Medium	
A	27,81	Archaebacteria and Eubacteria	Low	Dwijayanti, et al., (2016: 37)
B	20,34		Low	
C	25,93		Low	

Table 3.1 shows the percentage of misconceptions in six high school biology textbooks for class X. The misconceptions found ranged from 11.10% to 31.03%. According to Istighfarin (2015), 11.10% to 31.03% of misconceptions are low to moderate category misconceptions. That is, the biology textbooks for class X high school that have been studied are still feasible to use because the percentage of misconceptions found is still relatively low. However, although minimal, misconceptions still is a problem that must be addressed, so that the declining quality of textbooks as one commonly used learning resources can also be minimized.

According to Mappiara and Munirah (2020), a good textbook is a textbook that has minimal problems. One indicator of a textbook that has minimal problems is the lack of misconceptions. Textbooks with misconceptions will lead to misconceptions in students if the misconceptions in textbooks are not overcome by improving concepts by the teacher. According to Puspitasari, et al. (2019), one of the impacts of material misconceptions in textbooks is that it causes students' wrong thoughts and views in understanding concepts so that it limits students in learning efforts and will hinder understanding and development between concepts that were previously studied and those that have been studied afterwards. For this reason, efforts to improve concepts by teachers are needed to prevent the impact of misconceptions in textbooks. This can be done by the teacher by providing conceptual improvements directly to students during the learning process, both orally and in writing. Teachers must be able to strive so that sources of misconceptions such as textbooks do not have an impact on students by applying learning methods that can prevent students

Table 3.2 Percentage of Students Misconceptions on Biological Material Class X

Material	Concept	Percentage of Misconceptions (%)	Category Misconception	Source
Virus	Virus Characteristics	38,08	Medium	Setyaningrum, et al., (2018: 99)
	Basic Classification of Viruses	47,56	Medium	
	Virus Replication	74,91	High	
	Type and Host Virus	48,58	Medium	
	Viruses Cause Disease	44,33	Medium	
	Vaccine	46,12	Medium	
Archaebacteria and Eubacteria	Archaebacteria	26,00	Low	Kurniasih and Haka, (2017: 118)
	Eubacteria	25,00	Low	
	Bacteria Body Structure	25,00	Low	
	Bacterial Forms	24,00	Low	
	How Bacteria Get Nutrients	28,00	Low	
	Bacterial Reproduction	22,00	Low	
	Role	31,00	Medium	

from misconceptions. So it is hoped that the teacher can check the concepts in the textbook first before the concepts in the book are used by students. If misconceptions are found, it is hoped that the teacher corrects the misconceptions in the textbook during the learning process with students, so that these misconceptions do not become a sustainable problem and cause misconceptions in students.

Table 3.2 describes the percentage of students' misconceptions on biology material for class X SMA on the subject of viruses and the subject of archaebacteria and eubacteria. Based on Table 2, it is known that the percentage of students' misconceptions in biology class X ranges from 22% to 74.91%. Based on the opinion of Istighfarin (2015), it is known that students' misconceptions in class X biology material are classified as low to high misconceptions. That is, there is a difference in the percentage of students' misconceptions in each material and sub-material of class X biology. The difference in the percentage of students' misconceptions shows differences in students' ability to understand a material. In some materials, only a few students experienced misconceptions, but in other materials, there were more students who experienced misconceptions. Differences in the percentage of misconceptions in each material can be caused by several factors, such as differences in the level of difficulty of the material, differences in students' ability to understand the material, and other factors that cause misconceptions in students**.**

According to Setyaningrum, et al. (2018) students' misconceptions can be caused by: (1) lack of interest, motivation, and readiness of students in receiving the material; (2) students use textbooks that have misconceptions; (3) students believe in a wrong concept; (4) the teacher's learning method is not appropriate. According to Kurniasih and Haka (2017), students' misconceptions about archaebacteria and eubacteria material are caused by: (1) students' initial concepts are wrong; (2) the teacher's teaching method is not appropriate; (3) learning resources have misconceptions. Based on these opinions, it can be concluded that the common causes of the emergence of student misconceptions in class X biology material are: (1) student misconceptions caused by students' own factors, (2) student misconceptions caused by learning resources factors such as textbooks that have misconceptions material, and (3) students' misconceptions caused by the teacher's teaching method factors.

One of the common causes of students' misconceptions is the factor of textbooks being used as learning resources. This proves that textbooks that have material misconceptions will have a negative impact on students' understanding of concepts, one of which is causing misconceptions in students. It is hoped that teachers can be more selective in choosing textbooks that will be used as a reference for student learning, so that student misconceptions caused by textbooks can be minimized.

Table 3.3 Percentage Misconception Materials on Class XI Biology Textbook

Book	Materials	Persentage of Misconceptions (%)	Category Misconseptions	Source
Book A	Cell	9,00	Low	Fajriana, et al., (2016: 64)
	Plant tissue	16,00	Low	
	Animal tissue	23,00	Low	
	Movement System	27,00	Low	
	Circulation System	25,00	Low	
Book B	Cell	0,00	Low	Imran, et al., (2015: 59-63)
	Plant tissue	25,00	Low	
	Movement System	5,00	Low	
	Circulation System	0,00	Low	

Table 3.3 shows the percentage of misconceptions in two high school biology textbooks for class XI. Misconceptions in textbooks ranged from 0% to 27%. Based on the opinion of Istighfarin

(2015) about the category of level of misconception, the two textbooks analyzed were textbooks with low category misconceptions. That is, the two biology textbooks for class XI that have been studied are worthy books to be used by students as a learning reference, because there are only a few misconceptions. However, teachers and students should not just let the existing misconceptions and use the wrong concept even a little. According to Nugroho (2016), teachers and students are expected not to focus on one source of learning. So that if incorrect information is found, the information can be corrected by comparing it with various other sources. Thus, it is expected that teachers use various learning resources to avoid misinformation. Misconceptions in each textbook will affect students' misconceptions depending on the books used by students, according to the opinion of Fajriana, et al. (2016) that misconceptions of material in textbooks will affect students' misconceptions. It is hoped that the teacher can evaluate the concepts contained in the textbook before the concept is used. Then, the book writers, book publishers and BSNP are also expected to try to minimize the misconceptions that exist in textbooks, so that the quality of the textbooks in circulation is more guaranteed. In accordance with the opinion of Nugroho (2016), that to overcome misconceptions in textbooks, it is expected that the efforts of various parties, ranging from book authors, book publishers, BSNP, as well as teachers and students as book users, are expected. The efforts of the various parties involved, it is hoped that the quality of the textbooks in circulation will be guaranteed, especially in terms of information and material in the textbooks.

Table 3.4 Percentage of Students' Misconceptions on Biological Material Class XI

Material	Concept	Persentage of Misconceptions (%)	Category Misconseptions	Source
Plant tissue	Nature of Plant Tissue	38,23	Medium	Istighfarin, (2015: 993)
	Tissue Location in Plants	38,23	Medium	
	Epidermal Derivative Type	30,33	Medium	
Animal tissue	Epithelial Tissue Structure	16,25	Low	Sartika, et al., (2020: 1101)
	Muscle Structure	7,50	Low	
	Cartilage Structure	19,20	Low	
	Bone Structure	13,65	Low	
	Blood Structure	29,13	Low	
	Structure of the Nervous System	16,03	Low	
	Adipose Tissue Structure	6,00	Low	
Movement System	Muscle Structure	29,00	Low	Dini dan Raharjo, (2019: 250)
	Muscle Contraction Mechanism	36,00	Medium	
	Muscle Relaxation Mechanism	36,00	Medium	
	Bone Type	21,00	Low	
	Ossification Mechanism	33,00	Medium	
	Disorders and Disorders of the Movement System	33,00	Medium	
Circulation System	Blood Component	55,25	Medium	Khairaty, et al., (2018: 11)
	Blood vessel	52,25	Medium	
	Heart	66,22	High	
	Circulatory Process	60,54	High	
	Blood Coagulation Process	48,65	Medium	
	Lymph System	45,95	Medium	

Table 3.4 shows students' misconceptions on biology material for class XI, which ranges from 6.00% to 66.22%. Based on the opinion of Istighfarin (2015) regarding the category of levels of misconception, students' misconceptions on biology material for class XI SMA cover all categories, namely low, medium, and high. That is, the percentage of students who experience misconceptions on each material is different. It can be seen that in some materials only a few students experience misconceptions, but in some other materials, there are more students who experience misconceptions. This means that the level of students' ability to understand the material is different, and the level of difficulty in each material is different.

According to Solaikah, et al. (2013), there are students with high abilities who tend to master concepts quickly and precisely on materials with low to high difficulty levels. Students with moderate abilities have intermediate abilities, there are materials that can be mastered appropriately, and there are materials that are mastered incorrectly. Students with low abilities are a group of students who tend to find it difficult to understand a concept correctly, especially on material with a high level of difficulty. That is, students' misconceptions can be caused by the student's own factors. In addition, there are still several factors that cause misconceptions in students. According to Dini and Raharjo (2019), students' misconceptions are caused by the way teachers teach and the textbooks used by students. According to Nurulwati, et al. (2014), one of the causes of students' misconceptions about biology material in class XI SMA is misconceptions in the textbooks used by students. Textbooks play an important role in the learning process, namely as a source of learning material.

According to Rahmawati (2015), textbooks are one of the mandatory references used by educational units. If the textbook used has problems in the form of material misconceptions, the quality of the textbook will decrease. Misconceptions in textbooks will have an impact on students, one of which triggers student misconceptions. According to Mentari, et al. (2014), textbooks that have misconceptions will give the wrong view so that students have misconceptions about certain materials. Therefore, it is expected that teachers try to minimize the emergence of misconceptions in students, starting from ensuring students' readiness before receiving the material, using methods that make it easier for students to understand the material, and evaluating concepts in textbooks so that if there are misconceptions, these misconceptions can be corrected immediately before use by students in learning.

Table 3.5 Percentage of Material Misconceptions in Class XII Biology Textbooks

Book	Material	Percentage of Misconceptions (%)	Category misconceptions	Source
Book A	Growth and Development	26	Low	Agustina, et al., (2016: 117)
	Metabolism	26	Low	
	Heredity	26	Low	
	Evolution	9	Low	
	Biotechnology	13	Low	
Book B	Growth and Development	12	Low	Syahyani (2018: 77)
	Metabolism	26	Low	
	Heredity	38	Medium	
	Evolution	12	Low	
	Biotechnology	12	Low	

Table 3.5 illustrates the results of two articles on the analysis of misconceptions in biology textbooks for class XII SMA. The misconceptions in the two books ranged from 9% to 38%, based

on the opinion of Istighfarin (2015) regarding the category of level of misconception, the misconceptions in the two textbooks that have been studied are classified as low to moderate level misconceptions. This means that both books are still feasible to use because the misconceptions found do not reach the high category. However, these misconceptions must be corrected in the learning process to avoid students' misconceptions. Bukit (2011), explained that misconceptions in the material contained in biology textbooks will cause students' misconceptions to occur in high school biology material for class XII. According to Irani, et al. (2020), before the concepts in the textbooks are used in the learning process, the concepts should be analyzed first to ensure the correctness of the concepts to minimize the possibility of students using the wrong concepts in the textbooks. This means that efforts are needed from the teacher to ensure the correctness of the concepts in the reference books used, to minimize the impacts that may occur due to misconceptions in the textbooks. In addition, it is hoped that teachers will be more selective in choosing textbooks to be used as references, with one of the indicators being textbooks that have minimal misconceptions.

Table 3.6 Percentage of Students' Misconceptions on Biology Materials in Class XII

Material	Concept	Percentage of Misconceptions (%)	Category of Misconceptions	Source
Growth and Development	Growth	11,43	Low	Pradina and Yuliani, (2020: 313)
	Development	11,43	Low	
	Primary Growth	48,57	Medium	
	Secondary Growth	51,43	Medium	
	Germination	20,00	Low	
	Internal Factors of Growth and Development	41,43	Medium	
	External Factors of Growth and Development	32,86	Medium	
Heredity	Chromosomal Structure	27,69	Low	Sarhim and Harahap, (2015: 167)
	Relationship of Cells, Chromosomes, Genes and DNA	37,55	Medium	
	DNA Structure	34,07	Medium	
	DNA Replication	25,00	Low	
	RNA Structure	37,94	Medium	
	Difference between DNA and RNA	25,48	Low	
	Genetic Code	22,25	Low	
	Protein Synthesis Process	38,46	Medium	
Evolution	Darwin's Theory of Evolution	19,74	Low	Jannah and Setiadi, (2018: 10)
	Evolution Proof	55,26	Medium	
	Evolution Mechanism	56,58	Medium	

Table 3.6 shows the percentage of students' misconceptions on biology material in class XII which ranges from 11.43% to 56.58%. Students' misconceptions on biology material for class XII SMA based on the category of level of misconception by Istighfarin (2015) belong to the low, medium, and high categories of misconceptions. However, when compared to the misconceptions of class X and XI students, the misconceptions of class XII students are lower. This can be caused by internal factors of class XII students who are more prepared in the learning process, because class XII students tend to focus on learning. This resulted in a quite visible difference in the percentage of students' misconceptions between students in class X, XI, and class XII.

According to Maslihah (2011), the age of students will affect students in the learning process, starting in terms of motivation and ability to concentrate students in the learning process. So it is very possible if students with higher grade levels are better prepared to follow the learning process and obtain better learning outcomes. Apart from the internal factors of students, there are several other factors that influence students in understanding concepts, either correctly or experiencing misconceptions. According to Pradina and Yuliani (2020), the factors that cause student misconceptions are the teacher's teaching method, the learning context, and the textbooks used in the learning process. Sarhim and Harahap (2015) also stated that students' misconceptions were caused by a lack of student interest and motivation, and the textbooks used had misconceptions. Jannah and Setiadi (2018), state that students' pre-concepts are not appropriate, the teacher's teaching method is not right, and textbooks that have misconceptions can cause misconceptions in students. This means that, apart from internal factors, students' misconceptions can also be caused by external factors, such as the methods used by teachers in the learning process, and also the textbooks used by students.

There are various biology textbooks that have analyzed the concepts in the material to find out the level of misconceptions from the textbooks. The tendency of the results of the analysis is that every textbook has a misconception. So it is expected that teachers are more selective in choosing books that will be used as a source of material in the learning process. In addition, teachers are expected to be able to use the right method in each material and sub material, so that the possibility of student misconceptions that arise due to the teacher's teaching method can be minimized.

Based on the results of research by conducting a literature study on 15 articles, it is known that misconceptions in textbooks will cause students' misconceptions about the material. Sakti (2017), states that textbooks are the main source in the learning process, so that if textbooks have misconceptions about the material, this will influence students to use wrong concepts from textbooks continuously so that misconceptions in students become inevitable. So it is necessary to re-evaluate the concepts contained in the textbook to avoid misconceptions in students.

CONCLUSION

Based on a literature study conducted on 15 articles regarding misconceptions in biology textbooks and students' misconceptions on biology materials, it was found that every material in the textbooks that had been studied in the articles experienced misconceptions. Through the results of this study, it was found that of the 12 biology textbooks for high school studied in relevant articles, all textbooks experienced misconceptions with varying percentages on each material, which were then categorized into low, medium, and high misconception categories. It is known that the misconceptions contained in the textbook material are, on average, in the low to medium category. Still, there are also misconceptions of the material in the textbooks which are included in the high category. In the relevant article on the analysis of students' misconceptions of biological material, there are 14 biological materials that have been tested on students to determine the level of students' misconceptions in the material being tested, and it was found that students experienced misconceptions in the medium to the high category in each material. From the results of the analysis, it is known that there are three common causes of misconceptions in students, namely misconceptions in textbooks, misconceptions in teachers, and misconceptions in students' initial concepts. The causes of misconceptions in students are various, namely the lack of interest and motivation of students in learning, students' pre-concepts are not right, the teacher's teaching method is not right, and there are misconceptions about the material in the textbook. So it can be concluded that the existence of misconceptions in textbooks will cause misconceptions in students, so that students understand concepts in a material incorrectly.

SUGGESTION

One of the misconceptions in students is caused by textbooks, to avoid further misconceptions in students, an analysis should be carried out on other factors that cause misconceptions in students, such as misconceptions in teachers and misconceptions in students' initial concepts so that misconceptions in students can be minimized.

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