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The Science Literacy Profile Based on Madrasah Students' Misconceptions on Science Concepts

Hasan N. Hidaayatullaah [1,*]

[1] *Science Education Postgraduate Program, Universitas Negeri Surabaya, Surabaya, Indonesia*
[*] *Corresponding author. Email: hasan.20011@mhs.unesa.ac.id*

ABSTRACT
Students' misconceptions on physics lessons are believed to disrupt the development of understanding of other concepts because one concept with another in physics interconnected significantly. Therefore, misconceptions need to be diagnosed or analyzed and remediated. The purpose of this study is analysis the profile of *Madrasah Aliyah* students' misconceptions about basic electrical concepts. This study is qualitative descriptive. The subject of the study were twelfth grade students of Madrasah *Aliyah* (Public Islamic Senior High School) Sidoarjo of the Science Program. The three-tier diagnostic test was used as an instrument to analyze of students' misconception. The results showed that out of 100%, there were 57.65% of students experienced misconceptions, 18.82%, did not understand the concept, and 22.35% understood the concept correctly. Students' misconceptions on physics material happened within the concept of highest electricity with the percentage of 76.47% as well as in the concept of electrical resistance and the lowest misconception, namely the concept of the interaction of electric charges, happened to reach the percentage of 35.29%. Misconceptions among students need to be addressed with learning involving students to find their concepts through scientific or inquiry activities. This study can be continued by reducing student misconceptions through implementing the appropriate models, media, and strategies to improve conceptual understanding.

Keywords: *Misconception, Three-tier diagnostic test, Physics, Science literacy.*

1. INTRODUCTION

Education is an important aspect of educating the community. Education is considered to be able to change behavior and thinking in social life [1,2]. Based on the 2013 Ministry of Education and Culture Regulation No. 65, the vision of national education is to create learning conditions that make students participate in exploring their abilities who have good personalities, intelligence, noble character, and high religious spirituality [3]. Students must be able to explore knowledge, attitudes, and skills to live better in the era of globalization. Education is a process that is required for individuals and society to achieve balance and perfection in their development. The emphasis of education compared to teaching lies in the formation of awareness and personality of the individual or society in addition to the transfer of knowledge and expertise [4,5].

Physics is one of the main elements in the development and realization of science and technology. Every country is competing to find products, especially the results of science and technology. Science and technology cannot be separated from one of the main elements, namely physical science, which is useful for technological development [6,7]. Physics is also a part of education for all students; thus, physics has a very important role. The teaching and learning process Physics is frequently confronted with abstract stuff. Physics classes are still tough to grasp since they contain abstract notions that are difficult to link to everyday happenings in life. [8].

Physics learning requires good mastery of concepts because physics is a science that studies nature and natural phenomena and all interactions that occur in them starting from observing, measuring, analyzing, conceptualizing, and drawing conclusions [9–11]. Mastering the concepts of physics well also shows that students have understood the material well. However, in physics learning, there are often misconceptions or understanding of the wrong concept that hinders students in achieving learning goals [12]. The misconception is a consistent pattern of thinking on a problem but the thinking pattern is wrong. One of the ways to find out misconceptions is by doing a test [13,14]. The right test

is used to find out misconceptions can use diagnostic tests.

Various techniques can be used to detect misconceptions in students. One of them is to use the Three Tier Diagnostic Test [15–17]. The use of this test is expected to be able to identify between students who understand concepts, misconceptions, and do not understand the concepts, because in this test there are three levels of answers in the form of answers to multiple-choice questions, reasons for answer choices, and confidence in the previous two levels of answers. The measure of the level of confidence of respondents in answering each question or question given is analyzed to distinguish between students who experience misconceptions and those who do not experience misconceptions called CRI [18–20]. The main function of a diagnostic test is to identify problems or difficulties experienced by students and plan follow-up actions in the form of appropriate problem-solving.

This study was conducted in the Covid-19 pandemic that is happening in the world, including Indonesia. During a pandemic, there are restrictions on a human activity called physical distancing or social distancing. This also has an impact on the world of education [21,22]. Therefore, researchers cannot conduct a study directly but through one of the Google applications, namely Google Form [23,24]. Google Forms is an application from the Google website that is useful in helping to send surveys, give quizzes, or collect information easily and efficiently. This is in line with the development of digital technology in the 4.0 era, digital technology has great effectiveness, efficiency, and attractiveness aspects.

The purpose of this study is analysis the profile of *Madrasah Aliyah* students' misconceptions about basic electrical concepts. This study is expected to provide an overview of student misconceptions so that new models, strategies, learning media, and the material and substance of learning physics topics can be developed to remedy these misconceptions.

2. METHODS

This study is qualitative descriptive. The purpose of a descriptive study is to determine the value of the independent variable (independent) either one or more variables without comparing or connecting with other variables. The subjects of this study were all twelfth-grade students of *Madrasah Aliyah* Jabal Noer Geluran Taman Sidoarjo from the Mathematics and Natural Sciences Program. A purposive sampling technique was used in this study, so that the sample of 17 twelfth grade students were chosen. This source of data of this study is the primary data source because the data was obtained directly from the study participant [25,26].

The study was conducted by giving a written test using a multiple-choice diagnostic test instrument. Instruments were given to the sample to collect information related to students' misconceptions about electricity. The test instrument was developed based on the level of understanding of *Madrasah Aliyah* students with 5 case study items. This diagnostic test instrument comprises three levels: the first level is a choice of responses, the second level is a choice of reasons, and the third level is a choice of confidence based on the CRI (Certainty of Response Index) [27].

The data analysis was analyzed first by taking a look at students' answers in the form of multiple-choice results, the reasons for choosing answers in the form of essays or explaining the concepts in the selected answers, and the level of confidence in the answers according to the category of understanding level on the three-tier diagnostic test. The second step is coding to check the results of the instrument trial, then the researcher conducts a misconception analysis using CRI. The third step is tabulation for grouping to determine how many percent (%) of respondents' experience misconceptions [28]. Table I shows the categories of respondents' level of understanding based on CRI analysis categorized [29,30].

Table 1. Understanding level category

Answer	Reason	CRI value	Description
Incorrect	Incorrect	<2.5	Not Understanding the Concept (NUC)
Incorrect	Correct	<2.5	Not Understanding the Concept (NUC)
Incorrect	Incorrect	>2.5	Misconception (M)
Incorrect	Correct	>2.5	Misconception (M)
Correct	Incorrect	<2.5	Understanding the Concept Partly (NUC)
Correct	Correct	<2.5	Understanding the Concept but not Sure (UCNS)
Correct	Incorrect	>2.5	Misconception (M)
Correct	Correct	>2.5	Understanding the Concept Correctly (UC)

The following formula was used to calculate the percentage of each conceptual understanding based on response choice, reasons choice, and confidence level [31,32].

$$P = \frac{f}{N} . 100\% \quad (1)$$

Description:

P : Percentage of each level of understanding

f : Total number of students on every level of understanding

N : Total number of students

3. RESULT AND DISCUSSION

The data were obtained in the form of answer choices, choice of reasons, and level of belief were analyzed descriptively qualitatively and then classified the level of understanding of students' concepts based on the level of understanding of concepts with understanding the concepts correctly (UC), misconceptions (M), understanding the concepts but not sure (UCNS) and not understanding concepts (NUC). The results of the classification of the level of understanding of students' concepts of electricity are presented in Table III.

Table 2. Recapitulation of the percentage level of student understanding on each question

Case	Average Percentage (%)			
	UC	*M*	*UCNS*	*NUC*
1	35.29	35.29	5.88	23.53
2	5.88	76.47	0	17.65
3	29.41	58.82	0	11.76
4	29.41	52.94	0	17.65
5	11.76	64.71	0	23.53
Average	22.35	57.65	1.17	18.82

Description:

UC : Understanding the concept correctly

M : Misconception

UCNS : Understanding the concept but not sure

NUC : Not understanding the concept

Based on the table above, it is known that students can answer case questions or UC the highest in case 1, namely about charged object-band interactions with a percentage of 35.29% and misconceptions (M) also of 35.29%. Meanwhile, students experienced the highest misconception in question number 2 at 76.47%, which is about the factors that influence resistance. In case 3 students were able to UC with a percentage of 29.41% with students experiencing misconceptions of 58.82%. The question indicator in number 3 is about voltage and electric current. While in questions number 4 and 5 regarding electric current in series and parallel circuits, students can UC by 29,41% (case 4) and by 11,76% (case 5). The students' misconceptions from the two questions were the highest, namely in case 5 of 64.71%.

Students' performance in choosing answers, answering reasons, and the level of confidence in solving problem cases will affect the level of students' understanding of physics material about electricity. A summary of the profile of students' perceptions in solving problem cases on each question is presented in Table IV.

Table 3. Profile of the students' perceptions

Problem Case	Students' Perception
Case 1 (Interaction of electric charges)	All objects can be electrically charged (even if they are neutrally charged) and electrons cannot flow through a conducting wire.
Case 2 (Electrical Resistance)	Lamps with thick filaments are more resistant and lighter than those with thin filaments.
Case 3 (Voltage and Amperage)	- There is a potential difference in a high-voltage wire. - According to Ohm's law, a conductor with a voltage also has an electric current.
Cases 4&5 (Electric current in series and parallel circuits)	For all circuits, both series and parallel circuits, the quantity of electric current that emerges from the positive pole are the same. - The current value at each point in the series circuit varies depending on the resistor employed. - In the circuit, resistors consume current.

Students' perceptions shown in Table 3 are misconceptions experienced by twelfth grade students of *Madrasah Aliyah* based on 5 cases of questions given about electricity. In the case of static electricity, students still cannot understand the concept of the interaction of electric charges on objects. While in the concept of dynamic electricity, students also cannot understand electrical resistance, voltage, and electric current in everyday life. This problem demonstrates how students used intuition thinking to answer the question and demonstrate the motive. Intuition thinking is a type of thinking that arises from the observation of an object or a series of events and then occurs in real-time if challenged with a physical problem that arises spontaneously in the mind [33]. The average percentage of student's level of understanding is presented in Fig. 1.

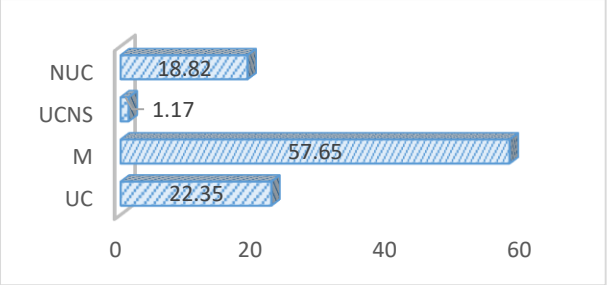

Figure 1 Students' average understanding level.

Based on Fig. 1, it can be seen that 57.65% of twelfth grade students of *Madrasah Aliyah* experience misconceptions about electricity in physics lessons. This is due to the large number of students who have incomplete initial conceptions that can be derived from uncertain circumstances according to experts. Students showed associative thinking as well, but they couldn't link events or phenomena in test items to concepts they learned. Their half comprehension level could lead to misconceptions since they could not connect complicated concepts and deliver logical and systematic explanations. As a result, a thorough understanding of the topic was essential in assisting learners in expanding their previous knowledge. This could be done by employing approaches, models, and media that aid with conceptual understanding. In their study, Suranti et al. [34] suggested that the project-based learning model assisted by virtual media on students' concept mastery. [35] applies to teach aids media to improve conceptual understanding.

Students' understanding of electrical concepts in Fig. 1 shows that the UC is 22.35% and the NUC is 18.82%. This shows that their ability to relate concepts is still low due to half-assessed concepts. Therefore, to increase their conceptual comprehension competence, they are required to use logical reasoning and critical thinking. In line with the study of Lemmer & Morabe [36] that analytical reasoning can remediate misconceptions. To raise learning motivation, students' grasp of the idea of dynamic electricity must be increased by developing understanding and reasoning abilities utilizing innovative and creative learning approaches [37]. Meanwhile, Nasiha, et al. [38] implied problem-based learning with the influence of peer tutors on improving critical thinking skills.

The results of this study provide an overview of the need for models, strategies, learning media, and the substance of creative and innovative learning materials to overcome students' misconceptions. Alfiyanti & Sukarmin [39] shows that the effectiveness of software as a learning medium is to detect and reduce misconceptions. In addition, Firdaus et al. [40] proves that using learning media can reduce misconceptions and can increase students' understanding of concepts. Interactive Conceptual Instruction (ICI) with computer simulation can facilitate students in the learning process so that misconceptions can be reduced [41]. The study by Astiti et al. [42] also shows that the application of the POE (Predict-Observe-Explain) Learning Strategy can reduce students' misconceptions about physics material. Therefore, the conceptual understanding of *Aliyah* madrasa students in the correct physics lesson must be developed by applying innovative learning models, strategies, and media to reduce and improve misconceptions.

4. CONCLUSION

Based on the results of the analysis, there were 57.65% of students experienced misconceptions, 18.82%, did not understand the concept and 22.35% understood the concept correctly. Students' misconceptions on physics material happened within the concept of highest electricity with the percentage of 76.47% as well as in the concept of electrical resistance and the lowest misconception, namely the concept of the interaction of electric charges, happened to reach the percentage of 35.29%. The conception of students about electricity material is influenced by their perceptions caused by experience, intuition to get conclusions, and understanding their initial concepts. This wrong conception can cause misconception. Thus, it needs to be overcome by involving students in learning process to find the concept through inquiry activities. This study can be continued by reducing student misconceptions through implementing the appropriate models, media, and strategies to improve conceptual understanding. Guided inquiry learning models or project-based learning models with virtual media are examples of learning models that can help students grasp concepts better

AUTHORS' CONTRIBUTIONS

All authors have different roles in the accomplishment of the study. For this manuscript, they contributed equally to the process of drafting, revision, and approval of the final revision.

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