Four-Tier Optics Diagnostic Test (4T-ODT) to Identify Student Misconceptions

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Abstract. Difficulty understanding student concepts needs to be known so that students can understand concepts well and avoid misconceptions. Diagnostic tests as a solution to reduce misconceptions of concepts in students. One type of diagnostic test is 4 tier tests. The purpose of this study is to determine the feasibility of the 4 Tier-Optical Diagnostic Test (4T-ODT) instrument in identifying misconceptions in students. Research is R&D with 4D models. The created 4T-MDT instrument consists of 20 multiple-choice questions. After the 4T-ODT instrument is validated, an average assessment of 84% is obtained, which means it is feasible to use and implement it to students. The results of the trial showed that as many as 15 items on the 4T-ODT instrument were valid and had high reliability. So that the 4T-ODT instrument serves to identify the profile of students' physics misconceptions on optical material.

Keywords: student misconceptions · diagnostic test · four tier test

1 Introduction

Mastery of concepts and development of students' science process skills is one of the goals of physics learning in schools. By learning physics, it is hoped that students will have a good mastery of concepts and science process skills. Understanding concepts is one of the important factors in learning physics [1, 2].

One of the physics materials studied in High School Class XI is optical material. The concept of optics must be well understood by students both in terms of theory, implementation of theory and physical equations. The teacher must be able to explain the concept of optics so that there is no misconception in students.

The results of the observation at SMA Negeri 4 Semarang stated that 60% of class XI students answered that optical physics material was the most difficult material to understand. It is difficult to understand the concept of optics because there are many formulas and misconceptions in understanding the material. Optical material in physics learning has concepts that must be thoroughly understood by students. There are many misconceptions in this material, some errors including the difficulty of students determining positive and negative signs at the distance of objects, having different understandings related to maximum and not maximum eye accommodations, errors in reading shadows formed in a mirroring or refraction. The learning strategies used by teachers are the main

J. Handhika et al. (Eds.): ICETECH 2022, ASSEHR 745, pp. 308–314, 2023.
https://doi.org/10.2991/978-2-38476-056-5_33

factor that causes the high number of students to experience Misconception in student material.

In addition, students do not study the material first before the material is studied at school, this causes students to have no initial knowledge, which has an impact on high student Misconception with physics material.

Concept error or misconception is an error caused in interpreting concepts that are not in accordance with the theory [3, 4]. According to Treagust, students' mistakes in understanding concepts will give rise to different interpretations and lead to misconceptions [5]. Misconceptions often occur when students cannot relate and understand the theory learned at school with their scientific phenomena [6]. Misconceptions are student thinking patterns that give rise to Misconception between the theory and those understood by students.

Misconception can be minimized by means of identification as early as possible [4, 7, 8]. One form of identifying misconceptions is to give diagnostic tests to students [9, 10]. This diagnostic test is a solution in finding student misconceptions. Diagnosis tests have three types of levels, they are two-tier diagnostic test, three-tier diagnostic test, and four-tier diagnostic test.

In this study, he developed the 4T-MDT instrument. Four-tier diagnostic tests are usually used to find out and identify levels about understanding concepts in students on a 4-level test. The advantage of the 4-level diagnostic test is that the difference in students' confidence in the concept between one student and the other will make it easier for teachers to be studied [11]. Misconceptions in students can hinder students from mastering physics concepts correctly. The purpose of this study is to determine the feasibility of the 4T-MDT instrument in identifying profiles and misconceptions of students' concepts in optical materials.

2 Method

This research is Research & Development (R&D) to develop and know the feasibility of the 4T-ODT instrument to determine student misconceptions on magnetic field material, with a 4D development model which includes the define stage, design stage, development stage, and dissemination. The instruments of this study are the 4T-ODT instrument sheet and the 4T-ODT instrument feasibility sheet.

After the instrument was validated by experts, the 4T-ODT instrument was then tested in a small class to students of SMA Negeri 4 Semarang. The data is processed to determine the analysis of the 4T-ODT instrument items on the validity, reliability, difficulty level, and differentiability of the questions. The data results are analyzed by the moment product validity test.

3 Results

The development of the 4T-MDT instrument uses a 4D model. In the Define stage, a needs analysis, curricular analysis, and material analysis are carried out. This is based on questionnaires and interviews that have been conducted to students of SMA Negeri 4 Semarang. Based on the results of the preliminary questionnaire analysis, it was obtained

that for the physics material of SMA Class XI, the one that experienced the most difficulties was the material about optics. Therefore, 4T-ODT was developed to see the level of students' misconceptions towards optical material.

At the Design stage, create a 4T-ODT instrument design. The 4T-ODT instruments that are contained include instructions for doing questions, modeling questions, making a grid of 4T-ODT questions, writing questions in multiple-choice form at the first level, writing down answer choices, writing down the belief choices of the answers at the 2nd level, writing down the basic choices of the answers at the 3rd level, as well as writing down the choice of belief in the reason at the 4th level and writing the answer key.

In the develop stage, the 4T-ODT Instrument that has been made as many as 20 items are validated by six experts who are experts in their fields. The purpose of the assessment by experts is to determine the feasibility of 4T-ODT. The assessment is carried out by 9 validators, namely physics material experts, language experts, and educational evaluation experts. The results of the expert assessment are seen in Fig. 1.

Based on Fig. 1, material expert scores were obtained at 81%, language experts at 84% and educational evaluation experts at 86%. So that the average validation of the 4T-MDT instrument was obtained 84% with the category "Feasible". Therefore the 4T-MDT instrument can be continued for small class trials to students.

There are several suggestions from experts, namely 1) The question should be contextual, 2) the appearance of the image should be clear, 2) it has no ambiguous meaning, 3) it uses scientific language, 4) there should be no negative meaning in making the question.

The next step is to test this small class to see the analysis of the question items. A small class trial was carried out to 36 students of SMA Negeri 4 Semarang class XI. Students are required to work on 20 items of the 4T-ODT form equipped with CRI to obtain validity, reliability, difficulty level, and differentiability for each item on the 4T-ODT instrument.

Of the 20 items of 4T-ODT grains, there are 15 valid items, namely numbers 1, 2, 3, 4, 5, 6, 7, 8.11, 12, 13, 15, 16, 17, and 20. Meanwhile, invalid items of 4T-MDT items are contained in items number 9, 10, 14, 18, and 19. At the difficulty level of the 4T-MDT question, there are easy category question items in items number 1, 2, 4, 10, and 11.

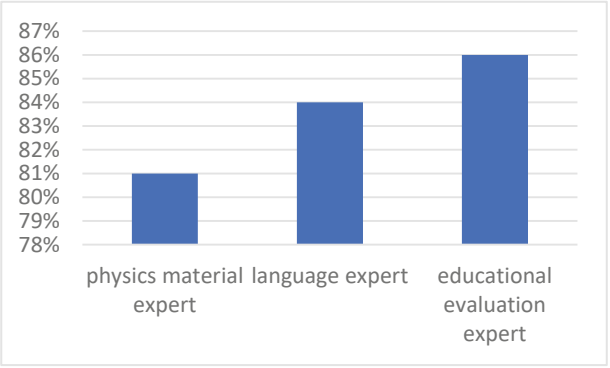

Fig. 1. The results of the feasibility assessment of the 4T-MDT instrument

While the items about the medium category in items number 6, 7, 8, 12, 13, 14, 15, 16, 17, 18, and 19. Items about difficult categories are found in items number 3, 5, 9, and 20.

In the category of differential questions, there are ugly categories contained in question items number 5, 9, 10, 14, and 17. There are enough categories there are three items number 8, 13, and 19. For good categories, it is found in items number 1, 2, 4, 6, 11, 13, 14, 15, 16 and 18. While in the very good category, it is found in items number 3, 7, 12, and 20.

In the reliability test, the rhitung result = 0.81 was obtained, meaning that the question was declared reliable in the high category. Based on the results of validity and reliability tests, it can be concluded that the diagnostic tests developed have a level of accuracy in revealing misconceptions experienced by students in Optical materials.

Figure 2 one of the contents of the question item in 4T-ODT. In 4T-ODT, the first level in the question item is a question statement, the 2nd level in the question item shows the student's confidence in the student's answer choice, the 3rd level is the reason for the student's chosen answer, and the 4th level shows the student's confidence in the reason for the answer.

The 4T-ODT instrument consists of question items that fall into the categories C1 to C6 according to Bloom's Taxonomy. The developed 4T-ODT instrument requires students to be able to think at a higher level (HOTS) as well as describe the profile of students' misconceptions on magnetic field material. Students in the ability to think at a high level (HOTS) will be able to distinguish ideas correctly, be able to communicate well, be able to solve solutions to a problem, be able to explain concepts, be able to explain hypotheses and understand complex things, so that students have good reasoning skills.

The test assessments that have been done by the students are analyzed and interpreted to find out the misconceptions experienced by the students. An analysis of misconceptions was performed on the student as a whole and each student, for each item of the question. Each student may experience misconceptions on the material they have studied. Students' misconception of a concept of physics is something natural and can be considered as the lack of success of the teaching and learning process. However, it is very important to develop an evaluation tool that can detect misconceptions experienced

12. Jika sudut antara sinar datang dan sinar pantul adalah 84°, maka besar sudut datangnya adalah…
A. 84°
B. 64°
C. 42°
D. 36°
E. 24°
Tingkat keyakinan Jawaban:
A. Yakin
B. Tidak Yakin
Alasan:
A. Sudut datang (i) sama dengan sudut pantul (r), sehingga menggunakan persamaan: i = r
B. Jumlah sudut antara sinar pantul dan sinar dating, sehingga berlaku rumus besar sinar datang: i + r = 84°
C. Jumlah sudut antara sinar pantul dan sinar dating, sehingga berlaku rumus besar sinar datang: i - r = 84°
Tingkat Keyakinan Alasan:
A. Yakin
B. Tidak Yakin

Fig. 2. Item display of four tier test questions

by students. This is because the misconceptions that occur will take root in students and hinder students from studying the material at the next level. One of the tools that can be used to detect student misconceptions is a diagnostic test.

Misconceptions are found based on the results of student answers and confirmed by the results of student interviews. Students assume that the law of reflecting light does not apply. Students also assume the bounce angle produced at the bounce is not the same as the angle of incidence. Another misconception found is that the rays coming and reflecting in the reflection that occurs in the rough plane are considered to be the same as those that occur in the smooth plane. When the rays that come to hit the reflected plane are aligned with each other, the reflected rays will also be aligned.

According to students, convex mirrors have a positive focus. They consider the object placed in front of the convex mirror to be virtual so that the distance of the object is negatively valued. In addition, students also consider the shadow behind the convex mirror to be of positive value. Biconvex lenses are considered negative lenses that are beam-dispersing. There are also students who know that biconvex lenses are positive lenses, but they are beam-diffusing.

Misconceptions are also found in microscope and binocular subcoctions. The magnification of the ocular lens on the microscope for the maximum amoded eye is the point near the eye divided by the focus of the ocular lens. The nature of the ayangan formed by the objective lens of the binoculars of the star is real, upright, enlarged.

Another misconception found was that biconvex lenses had negative focus. Biconcave lenses are considered positive lenses. Biconcave lenses are considered to have the property of collecting rays. Another misconception found is that negative lenses are light-collecting and fast light propagation is always the same in all mediums. The object depicted to the right of the lens is always virtual, regardless of the direction in which the rays come. According to students, the virtual shadow is always reversed. The shadows produced by positive lenses are always real.

Misconceptions are very dangerous for students, so they should be detected as early as possible. The negative impact of misconceptions, among others, can result in a low concept of mastery of the material so that the learning outcomes are also low, misconceptions if left alone will be fatal which if continued to be done by students, students will use the wrong theory to be applied in daily problems [12, 13]. Many have done research and development regarding diagnostic tests, of two-level, three-level or four-level types.

Developed 4T-ODT instruments in the form of multiple-choice test types. Multiple choice tests are the best alternative to diagnose a large number of student misconceptions. Because it is more effective and efficient and has better validity and reliability than the interview method [14–16].

In line with Wahyuni's research, the four-tier test instrument developed on circular motion material can be used to determine student misconceptions [17].

Based on the advantages of the four-tier diagnosis test, it is necessary to develop a four-tier misconception detection instrument that will produce quality diagnostic test products [18]. The four-tier diagnostic test is one of the efforts to overcome physics misconceptions in students [15, 19, 20]. From the results of this test, teachers can design learning methods, choose the right learning media and can identify student

misconceptions on optical material, so that students have the correct understanding of concepts.

4 Conclusion

Based on the results of the analysis, it can be concluded that the 4T-ODT instrument developed gets an average percentage of validation of 84%. The results of the trial were as many as 15 items of instrument questions that have high validity, high reliability, good differentiability, and a good level of difficulty. So that it can be used to find out the profile of students' physics misconceptions on optical materials. The 4T-ODT instrument is able to map conceptions on optical materials and this 4T-ODT can be used as an alternative instrument in evaluating physics learning to reduce physics misconceptions in students.

Acknowledgments. Thank you to the Ministry of Cultural Education, Research, and Technology and the Directorate General of Higher Education, Research, and Technology for providing funding for the 2022 Penelitian Terapan Unggulan Perguruan Tinggi (PTUPT). Thank you also to LLDIKTI Region III and LPPM Universitas Indraprasta PGRI for providing support for research activities.

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