Use of the four-tier diagnostic test with PIMCA model on learning of microscope

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Abstract. In learning physics, students often find misconceptions. This research aims to determine misconceptions on the subject of an optical microscope by using the four-tier diagnostic test with the PIMCA model (Presentation, idea mapping, conceptualization, and assessment formative) which was introduced and developed by Cosmas Poluakan. The method used is the One Group Pre-test – Post-test Design with 24 respondents as prospective physics teacher’s students at the Department of Physics, Manado State University. The instrument used is a test instrument in the form of a (four-tier diagnostic test). The research started with the pre-test, the implementation of the physics learning followed the 4 steps of the PIMCA model and ended with a post-test. The results showed a pre-test average value of 45 and the average post-test value of 93. Based on the research results, it is shown that the learning outcomes of the students with the PIMCA MR-SR learning model increase on the subject of the optical microscope.

1. Introduction
There are many studies in physics education that focus on testing misconceptions and how these misconceptions can hinder students from learning and conceptual understanding [1]. A person's conceptual understanding is formed from natural phenomena or natural phenomena that they see. These initial ideas, ideas, and understandings are called alternative concepts. and preconceptions [2]. If the alternative concept that students have is the same as understanding scientific concepts, then the student experiences understanding of the concept, but if the alternative concept that the student has is different from understanding the scientific concept then the student experiences a misconception.

A previous study developed a valid and reliable "two-tier" test for assessing student performance and misunderstanding. The two-level test can provide both quantitative data and qualitative data (students' thoughts in relation to their reasons and the possible causes of their misunderstanding) [3]. The results of previous studies he development of the "two-stage" test form show that the two-stage test can identify and even know more precisely the cognitive abilities of students [4]. This study Using the results of a four-level test where the four-level test can help to reveal the level of confidence of students about their responses. For example, a correct answer with a low level of confidence allows students not to really understand a concept, but may just have a lack of understanding. In addition, the level of student confidence can also provide information about the level of misunderstanding. For example, a misunderstanding with more than 80% confidence level can be categorized as a strong misunderstanding. In research conducted shows that students tend to think problems in the level of
answers easier than those at the level of reason [5]. Previous research into the development of one-tier, two-tier, and three-tier diagnostic tests has shown that diagnostic test can detect misunderstandings from students and help teachers find misunderstandings in students [6]. The results of previous studies used a four-tier diagnostic test to identify student misunderstandings in geometric optics. The four-tier diagnostic test is an extension of the three-tier test by giving more confidence to each answer and reason. The existence of this diagnostic test is able to require students to be more careful in choosing answers [7].

The research results of show that the FCI instrument in the four-tier format can diagnose the degree of conception of students in relation to the concept of force [8]. Related research and the results show that the four-level diagnostic test tool can identify misunderstandings by category: conceptual understanding, misunderstanding, lack of conceptual understanding, or error [9]. Therefore, the students’ confidence in the answer level may be higher than that at the basic level. The use of these tools can increase student learning outcomes. This research aims to determine misconceptions on the subject of an optical microscope by using the four-tier diagnostic test with the PIMCA model (Presentation, idea mapping, conceptualization, and assessment formative) which was introduced and developed by Cosmas Poluakan.

PIMCA is a new learning model which is a development model from MOMBI which was introduced and developed by Cosmas Poluakan but refined in the MR-SR-based teaching and learning process developed from the Vygotsky ZPD concept with DRPRM Master Research 2020/2021 “Semiotic Resource-Based Class Formative Assessment Model In Physics Learning [10]. Theory Vygotsky more emphasis on the social aspects of the learning process. According to Vygotsky, the learning process will occur if the child works or handles tasks that have not been studied, but these tasks are still within their reach, which is called the Zone of proximal development, which is an area where the level of development is slightly above one's current development area. The zone of proximal development is a series of tasks that are too difficult for children to master alone but can be learned with the help and guidance of a trained adult or child. The most basic stage of Vygotsky's theory is scaffolding, which is providing assistance to students through the stages of learning and reducing this assistance and providing opportunities for students to continue working [11]. Vygotsky said that the two main meanings of learning occur through social and language interactions [12]. The teachers are considered as the more knowledgeable other [13] since their constructive role in the learners’ development in providing the needed social interaction within the classroom context [14]. Social engagement and contribution also play a key role in students’ learning process as they are involved more in collaborative work [15].

The PIMCA is models (Presentation, Idea Mapping, Conceptualization, assessment formative) model is a model based (Multiple representation - semiotic resources) developed from MOMBI from. The MOMBI model is based on a situation, that is, when an individual is faced with new learning material or a task, the individual constructs a mental model that combines it with the readiness of existing knowledge, where the mental model is not immediately stored but is reconstructed for some time into a scheme that is learned. The new learning model developed based on MOMBI and MR-SR based is called the PIMCA learning model, consists of 4 steps namely: 1) Presentation, which is the step in which learners get initial information through the presentation of various forms of representation. 2) Idea Mapping, namely the stage where the learner constructs concepts and builds conceptual relationships based on information received from various forms of representation. 3) Conceptualization, namely the stage where learners receive information and provide assistance from lecturers / teachers who function as resource persons and / or facilitators and / or tutors, so that scaffolding can take place. 4) Assessment Formative, namely the stage to ensure that the concept of knowledge constructed by the learner is correct. The formative assessment stage can function as a scaffolding assessment.

According to Giancoli [16], "a microscope has an objective and an ocular lens that are designed differently from the telescope because it is used to see objects that are very close so that the distance from objects is very small ". When observed with a microscope, the objective lens produces a real, inverted and enlarged image. The image produced by the objective lens is the object of the ocular lens. Then the image from the lens of the eye is reproduced as an image that can be observed by the viewer.
2. Methods
The research used is an experiment with a quantitative approach that aims to identify misconceptions and learning outcomes using the PIMCA (presentation, idea mapping, conceptualization, formative assessment) model. This research was conducted at the beginning of the odd semester of the 2020/2021 school year, which was conducted at the Department of Physics at Manado State University. The respondents in this study were students in the 3rd semester of the 2020/2021 academic year with 24 respondents with a focus on physics. This research uses One Group Pretest-Posttest Design. There are two variables in this research, namely the treatment and response variables. The specified tests consisted of a pre-test, a four-stage diagnostic test and a post-test. Based on the processing and analysis of research data using the PIMCA model, it is shown that there are differences in the learning outcomes of physics after the application of the MR-SR-based PIMCA learning model. If the mean pre-test score is 45 and the post-test mean is 93, the histogram shows figure 1.

![Histogram pretest and posttest](image)

Figure 1. Histogram pretest and posttest.

3. Discussion
Based on the analysis data, the students were unable to describe the formation of the image that is in the material of the optical microscope and does not take into account. As measured by the histogram graph, the mean pre-test value is 45 and the mean value after the test is 93, and the results of the study were then tested for data normality using the Kolmogorov-Smirnov test with the aid of SPSS with a significance of 0.05. Based on the normality test, a significant value of 0.07 was obtained, so it could be concluded that the data were normally distributed. Based on the analysis of research data using the MR-SR-based PIMCA learning model, it is shown that the score from pre-test to post-test.

Based on comparing the three previous studies by applying different models, namely models problem based learning, Project Based Learning, and inquiry. Compared to the PIMCA model used by researchers for research purposes, the pretest and posttest results from the three previous research results with the models problem based learning, Project Based Learning, and inquiry. On figure 1 shows the histograms before and after the test using the PIMCA model, the results of the histograms showing that after using the PIMCA model, there is an increase from the pretest to the posttest.
4. Conclusion

Based on the results of research and discussion it can be concluded that student learning outcomes increase after using the PIMCA model. The PIMCA learning model is therefore very effective and suitable for use in the learning process, as it can make it easier for students to understand physical concepts with the steps from the PIMCA learning model. Seen from the histogram, the average result of the pretest value is 45 and the average result of the posttest score of 93 shows that there are differences before and after the application of the PIMCA model. Some suggestions that researchers may make to optimize the use of the PIMCA model namely the initial ability, should be given due consideration so that the implementation of the learning can produce the expected results. If the presentation of the material is to be explained, the explanation must be clear so that students can understand the concepts of the material being described.

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