

Analysis of student difficulties in learning refraction of light

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1 Analysis of student difficulties in learning refraction of light

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Abstract. The use of semiotic resources in developing abilities and skills in physics problems is very important. PIMCA learning model (Presentation, Idea Mapping, Conceptualization and Formative Assessment) introduced and developed by Cosmas Poluakan is the focus of this research. The purpose of this study was to analyze student difficulty on learning the refraction using the PIMCA model based on multi-representation (MR). The type of research used experimental research with one group pretest-posttest design. The research was conducted in the Department of Physics, Manado State University, with 23 students as respondents. The test instrument used for this research has been validated. After processing and analyzing the data, the pretest average score was 15.9 and the posttest average score was 60.2. These results indicate that even though there is an increase in the average proportion of mastery of the refraction of light concept, generally students still have difficulty drawing the angle of incidence, direction of refraction and the position of refraction for the arrangement of 2 mediums. The results of this research recommend that in order to understand the concept of refraction, the use of the PIMCA model needs to provide more practice questions.

1. Introduction

Physics often uses representations to abstract forms such as pictures, diagrams, words, graphs, and equations [1]. Multiple representations can provide unique benefits when people are learning complex new idea [2]. Based on research conducted by Taqwa the multi-representational approach is effective in improving student conceptual abilities [3]. The use of multiple representations on student learning outcomes is better and has a positive effect after applying multiple representation compared to student learning outcomes before applying multi-representation [4]. Multi representation is very important in physics education because it can develop students' understanding of physics problems, and helping students develop ideas on mathematical symbols [5]. Based on several points of view mentioned above, it is necessary to conduct a study to identify the use of multiple representations in various physics cases and identify questions that wrong answers in topic refraction of light.

Students have significant misconceptions about the direction of light refraction, how light is refracted and how to determine its position from an image [6]. Light is represented as rays, namely straight lines drawn in the direction of light propagation [7]. The results of studies on misconceptions emphasize the importance of concept teaching. From elementary school to college, light refraction is one of the subjects that continues to present difficulties for students [8]. Fredlund examined a group of physics students using multiple representations to describe the refraction of light on a ray diagram. The results of Fredlund's research indicate that there is interactive involvement of students in learning using multiple representations [9]. Optics is one branch of physics that must require pictures in explaining the concept of refraction of light.

PIMCA (Presentation, Idea Mapping, Conceptualization and Assessment Formative) learning model introduced and developed by Cosmas Poluakan is a development model from MOMBI but emphasizes the MR-SR based teaching and learning process. The MOMBI model is derived from the theory developed by Ulrike Hanke, namely the mental models theory, so the new MR-SR based learning model is developed from Vygotsky's ZPD concept. Mental model theory assumes that learning is a form of information processing. When individuals are faced with a new learning subject or task, they must build a mental model that integrates their existing knowledge and new information from the learning environment [10]. Mental models need teacher involvement in supporting the student learning proses.

Cognitive development is the progression of the ability to think and reason [11]. Vygotsky's cognitive theory is a theory which says that the learning process and increased knowledge come from social interactions and cultural aspects [12]. There are two important elements in Vygotsky's view of cognitive development. ZPD (Zone of Proximal Development), the zone of proximal development is the zone between what a child can achieve with the help and guidance of adults or peers [13]. Scaffolding, according to Wood scaffolding is teaching support to students to assist in completing the learning process that cannot be completed alone, the concept of scaffolding is closely related to the ZPD concept [14]. Vygotsky's theory is seen to have a positive role in developing children's thinking abilities through social interaction. The purpose of this study was to analyze student difficulties on learning the refraction using the PIMCA model based on multi-representation (MR). Apparently there is a difficult in understanding students about the concept refraction of light.

2. Methods

The research was conducted in the Department of Physics, Manado State University with 23 students as respondents. The test instrument used has been validated. The type of research used experimental research with one group pretest-posttest design. This study used the PIMCA learning model. The PIMCA learning model by Cosmas Poluakan consists of 4 steps, namely: 1) Presentation, namely the step in which learners get initial information through the presentation of various forms of representation; 2) Idea Mapping, which is the stage where learners construct concepts and build conceptual fabrications based on information received from various forms of representation. At this stage the concept map that learners build may not yet be mature; 3) Conceptualization, which is the stage where learners receive information and are accompanied by instruction assistance from the teacher / lecturer who functions as a resource and / or facilitator and / or tutor, so that the scaffolding function can take place. At this stage, the immature idea mapping is corrected and constructed into the correct concept so that later misconceptions are not built; 4) Formative assessment, which is the stage to ensure that the concept of knowledge constructed by learners is correct. The formative assessment stage can serve as a scaffolding assessment. Formative assessments can be used as a basis for diagnostic work. Participant's weaknesses are examined one by one. Participant's answer data is processed and analyzed, and the results are shown in Figure 1 and Figure 2.

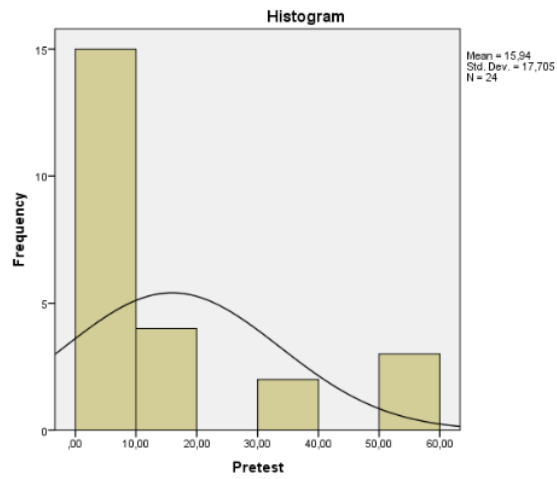


Figure 1. Histogram of pretest.

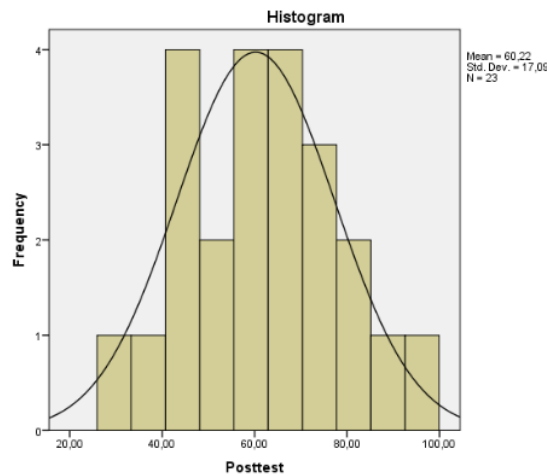


Figure 2. Histogram of posttest.

3. Results and discussion

Based on the data in Figure 1, an indication of the most difficult physics concepts is shown in relation to multiple representations. As in table 1 above in question number 95,6% students cannot describe the angle in the refraction event, 91,3% students cannot describe the angle of incidence in the refraction event, 86,9% students cannot draw a normal line in refraction, 82,6% students could not describe the direction of the refraction and the position of the refraction. According to Tural geometric optics is a difficult topic for students in the physics discipline [15]. Students find geometric optics topics that are unclear and difficult [16]. According to Poluakan Many students answered incorrectly the pictures of the process of light propagation because they do not understand the concept of waves front of light and light rays [17]. Student have low understanding abilities and many misconceptions about light propagation,

light refraction [18]. Indications show that the students of physics concepts is not yet complete, many students still do not understand the concepts even though they have studied.

4. Conclusion

Based on the results of research that has been carried out on students with a number of respondents 23 students of physics education at Manado State University on light refraction, it appears that the average analysis of student learning outcomes is better after applying the multi-representation based PIMCA learning model and it is recommended to understand the concept of more light refraction in, the use of the PIMCA model needs to be accompanied by the provision of more practice questions. Apparently with the PIMCA model, there is still a misconception. There is no one model that guarantees all learning problems are complete. In physics learning requires high concentration and various representations. The use of multiple representations is good for use in other science learning such as mathematics, biology, chemistry and other fields of science

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