Teaching convex Lens materials with a PIMCA model

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Abstract. This research is based on learning physics on convex lens material with the PIMCA model based on MR-SR (multiple representation - semiotic source). PIMCA (Presentation, Idea Mapping, Conceptualization, Formative Assessment) is a new learning model based on MR-SR which was introduced and developed by Cosmas Poluakan. This study aims to see the increase in the average learning outcomes of physics education students in the odd semester. The method used in this research is quantitative comparative design with one group pretest-posttest design. The research was conducted in the physics education department of Manado State University with 24 students as respondents. The instrument used has been tested and validated. The research procedure starts from the initial study on students and then the pretest then performs 4 stages of the PIMCA model (presentation, idea mapping, conceptualization, formative assessment) then posttest. From the results of data processing & analysis, it was found that the average pretest score was 23 and the average posttest score was 79 with a standard ideal value of 75, then the gain-test value was 1.0769 where the data showed a high increase in learning outcomes after the implementation of PIMCA. And it can be concluded that the PIMCA learning model is very good at improving understanding of the concept of the convex lens.

1. Introduction

A representation is something that symbolizes or stands for objects and or processes. Examples in physics include words, pictures, diagrams, graphs, computer simulations, mathematical equations, etc. Some representations are more concrete (for example, sketches, motion diagrams and free-body diagrams) and serve as referents for more abstract concepts like acceleration and Newton’s second law they help student understanding [1].

Several studies investigated whether the use of multiple representations in courses affected student problem solving. De Leone and Gire [2] studied how many representations students in a reformed course used when solving open-ended problems on quizzes and tests.

The application of the model and the selection of methods in learning physics that are appropriate in presenting a physics material can help students understand everything that is presented by the teacher, so that through the test results of learning can be seen the increase in student achievement. According to Yusup [3], multi representation can help students optimize student learning opportunities in different ways according to the type of intelligence (multiple intelligences). With multiple representations in planting physics concepts will be able to better help students in understanding the physics concepts being learned. Quantities and concepts that are physical in nature can often be better visualized and understood using concrete representations, some concrete representations help in constructing more abstract representations.
PIMCA is a new learning model based on Multiple Representation - Semiotic Resources which can be an alternative and can be used to improve concept understanding and problem solving skills and improve student learning outcomes. This learning model is expected to help students improve their learning outcomes and mastery of physics concepts, especially convex lens material, with the help of animated pictures, visuals, sketches, diagrams, graphics, mathematical formulas, videos, physical demonstrations and so on. This PIMCA learning model consists of four stages, namely: (a) Presentation, (b) Idea Mapping, (c) Conceptualization, (d) Assessment (Formative). The purpose of this study is to find the outcomes from the student of physics education using a PIMCA Model based on multiple representation – semiotic resources [4-6].

2. Methods
The research used a comparative quantitative method designed by one group's pretest posttest design and this study was done in the physics department of manado state university with 24 student respondents. the instrument is used for multiple representation-semiotic resources tests that have been tried and validated the research procedures begin with pretest before beginning the lesson to learn the students' initial ability then begin the lessons by using a pimca model and then done posttest to know the student's final ability after following the lesson with the pimca model. From the results of data processing and analysis, it was found that the average pretest score was 23% and the average posttest score was 79% with a standard ideal value of 75%, then the Gain test was carried out to find out how much increase the average student learning outcomes so that the value was 1.0769. where the data shows a high increase in learning outcomes after the implementation of the PIMCA Learning Model. We can see in the table for the distribution of the gain test score where if the value is less than 0.3 then it is categorized as low, for values between 0.3 to 0.7 then it is categorized as moderate and if the value shows more than 0.7 then it is categorized as high.

![Histogram data pretest and posttest](image)

Figure 1. Histogram data pretest and posttest.

| N – Gain Test | Category |
|---------------|----------|
| $g > 0.7$     | High     |
| $0.3 \leq g \leq 0.7$ | Middle |
| $G < 0.3$     | Low      |

Source: Meltzer, David E. (2002) [7]
3. Results and discussion

Based on preliminary data analysis, students have not been able to describe the process of forming an image on a convex lens and determine the location of the image and the direction of the rays formed. It can be seen in the results of the graph histogram that the highest pretest value is 50 and the lowest value is 0. After being given the PIMCA learning model treatment, the final (posttest) score increases and there are differences in learning outcomes before and after the application of the PIMCA Learning model in the learning process. And the posttest results show the highest score is 100 and the lowest score is 50. The data is then processed using parametric statistics which are calculated with the help of the SPSS 22 application which states that the results of learning physics after the application of the PIMCA Learning Model on odd semester students of Physics education at Manado State University increased drastically.

This research is also supported by a comparison of the learning outcomes of the convex lens material with different learning models and methods, namely with 49 students who are then divided into 3 groups with the physlets model for 17 students, and 15 students for the static image model, and 17 students with the model. Traditional presentation of static images, thus getting results that show the use of physlets is superior to static images and presentation of static images. In fact, the Physlets interactivity feature facilitates active student participation in classroom processes, which results in more intensive engagement with cognitive processes relevant to learning [8].

In the context of teaching about lenses, the benefits of using animation are related to the fact that one can easily track a large number of rays emitting from many different points of light. objects that are not easy to do in a traditional approach. Change the object's position and Visualizing how changes in position affect the propagation of light through the lens helps students to better understand the point-to-point correspondence between objects and images, as well as the role of the principal of the beam [9-11].

It seems that, in the context of teaching about lenses, the printed sequences of static Physics accompanied by appropriate worksheets have the potential to trigger similar cognitive processes as dynamic physlets. Consequently, no statistically significant difference between the dynamic physics approach and the static filet approach was detected. In general, the level of effectiveness of a visualization is closely related to its potential to represent a barrier context to trigger higher cognitive processes and useful classroom discussions [12-14]. Our study suggests that it is advisable to accompany instructional visualization with explicit tasks that guide learners through the process of qualitative and/or quantitative analysis of visual data. Which of course is in line with the research that the author has carried out where by applying multiple representation - semiotic resources is very effective in improving learning outcomes in the learning process because it makes students feel less bored and easier to understand concepts than mathematical explanations. There is also a study conducted by Parsaoran Siahaan et al, who both use test-gain to see if there is an increase in learning outcomes for students after studying a treatment, in this case physics learning material with convex lenses with the help of Integrated Instruction Learning Media (MBI2). Where the research results show good results even though the value or category of the acquisition test score is 0.42 which is not yet in the high category but how many are in the medium category, which means that learning is going well so that it produces sufficient scores [7].

4. Conclusion

The conclusion is that the application of the learning model or method using (MR-SR) multiple representations-semiotic resources or media is very good and effective in the learning process to make it easier for students to understand concepts visually without having to think hard to understand the concept mathematically. with the multiple representation-semiotic resources-based PIMCA learning model (MR-SR), the authors obtained the results of research and discussion which showed that the pretest average score was 23 and the post-test average score was 79. PIMCA learning model is very well used in the learning process as it can We saw previously that the posttest and test-gain histogram graphs show the high category of improvement in the average student learning outcomes, and of course this
learning model can be a reference for teachers in the learning process, because it is easy for students to understand the concept well.

Acknowledgement
Thanks to DRPM (Directorate Of Research And Community Service) of Indonesian government who has given funds through Prof. Dr Cosmas Poluakan M.Si chairman of a research project 2019-2020; thanks to the committee IWMANSELEN 2020 which has facilitated the author as a presenter. Thanks to the Rector of Manado State University and Dean of the Faculty of Mathematics and Natural Sciences. Thanks to the promotor of my research manuscript, and Thank you to all the research teammates who have helped a lot during the research.

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