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Improving Student's Creative Thinking Skills using *the Case Based Learning* (CBL) Model assisted by Virtual Laboratory Media on Optical Materials

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Abstract. The research aimed to assess the improvement of students' creative thinking skills through the implementation of the Case Based Learning (CBL) model, supported by a Virtual Laboratory, in the topic of Optics. The method used was Classroom Action Research (CAR) involving 41 students from class XI MIPA 6 at SMA Negeri 6, Kabupaten Tangerang. The research was designed in three cycles, each consisting of four stages: planning, action, observation, and reflection. The results indicated that the application of the CBL model, assisted by the Virtual Laboratory, significantly enhanced students' creative thinking abilities. The average percentage of students categorized as "Highly Creative" increased from 12.1% in the first cycle, to 29.2% in the second cycle, and reached 58.04% in the third cycle. Meanwhile, the percentage of students in the "Not Creative" category decreased from 24.3% in the first cycle, to 9.7% in the second cycle, and dropped to 0% in the third cycle. These findings suggest that integrating the CBL model with a virtual laboratory is not only effective in boosting creative thinking skills but also in deepening students' understanding of physics concepts visually. The implications of this research indicate that the use of Virtual Laboratory within the CBL model provides a strong framework for innovative teaching practices in physics education, which can enhance the effectiveness of learning and student motivation.

Keywords: case based learning (CBL), *virtual laboratory, creative thinking ability*

1. Introduction

The 21st century is known as an era of rapid development in science and technology, becoming a major aspect in shaping human life [1]. Along with this, there is a growing need to create high-quality human resources, those who possess broad knowledge and competent skills [2]. In order to produce a generation with such quality, improving the quality of education becomes essential. In Indonesia, efforts to enhance the quality of education are realized through various ongoing reforms [3], one of which is the implementation of a new curriculum designed to meet the needs and goals of education, especially in developing specific skills [4]. This curriculum is known as the "Merdeka Curriculum," which emphasizes the concept of fostering an active and creative student mindset to develop high-level creative thinking skills in utilizing the knowledge they possess, both in the present and future [5].

Creative thinking skills have become one of the main goals of education, and teachers worldwide strive hard to achieve this through various teaching methods. Lack of practice in creative thinking can result in limitations in the thought process and deficient problem-solving abilities. Students tend to rely on memorization in solving problems, indicating their poor critical thinking skills [6]. Therefore, improving creative thinking skills becomes crucial in helping students generate ideas from different perspectives that can be developed as problem-solving solutions. Students with creative thinking skills will find it easier to find solutions by connecting concepts they have mastered in various situations.

In the context of physics learning, many students face significant difficulties, especially in understanding abstract materials. One of the most challenging topics is Optics, which often leads to low creative thinking skills among students [7]. These difficulties include various aspects, from conducting experiments with optical tools, creating ray diagrams on lenses and mirrors, to solving mathematical problems related to the topic [8]. Observations and interviews at SMA Negeri 6 Kabupaten Tangerang show that students often struggle to apply physics concepts when faced with new problems, especially abstract ones like Optics.

To overcome these challenges, a learning model that actively engages students and fosters creativity is needed. One suitable model is the Case-Based Learning (CBL) Model. This model is based on problem-solving through relevant cases, where students are presented with real or realistic situations to make decisions or solve existing problems [9]. Case-based learning allows students to see the relationship between the material learned and daily life, so they are accustomed to solving contextual problems. The Case-Based Learning (CBL) Model requires students to have knowledge of previous material, which can be used to discuss the cases they encounter [10]. This trains students to apply the knowledge and concepts they have learned to solve the problems they face.

The stages in the Case Based Learning (CBL) model include case presentation, case analysis, information, data, and literature search, case resolution, conclusion drawing, and presentation of results and verification of answers. The stages of case presentation and analysis are very useful in training students to formulate problems and translate them into mathematical language, which can improve students' ability to formulate problems mathematically [11]. In addition, case analysis trains students to think critically and express opinions, while exploring various ideas related to physics problems. In the stage of information, data, and literature search, students conduct experiments in groups, which require supportive learning media. However, the limitations of experimental tools in the school laboratory are a major obstacle in this process. Therefore, virtual laboratories are introduced as a solution that allows students to conduct experiments effectively, visualize abstract physics concepts, and overcome the limitations of equipment in the school laboratory.

Virtual laboratories, as a form of experimental simulation, offer a solution to overcome these limitations. Through this media, students can develop creative thinking skills while conducting experiments. Virtual laboratories can also be an important supporting factor in increasing students' motivation to learn physics interactively and in-depth [12]. One example of learning media that can be used is the PhET simulation, developed by the University of Colorado. This media displays theoretical and experimental simulations with active user participation [13]. The use of the Case Based Learning (CBL) model with the help of the PhET simulation media has been proven to enhance students' understanding of physics concepts [14]. Thus, this media can also help improve students' learning outcomes, as they are more directly involved in experimental activities [15].

In physics, many concepts are abstract, requiring more time and effort to ensure that students truly understand them [16]. Optics material, which is mathematical, abstract, and theoretical, often poses a significant challenge for students. Students' lack of understanding of optics concepts, such as image formation in the eye, loupe, microscope, and telescope, indicates the need for a more effective approach to teaching optics [17].

Based on the issues outlined above, it is crucial to test the implementation of the Case Based Learning model in physics education, especially in optics material. This research aims to answer the following questions: (1) How can the implementation of the Case Based Learning model enhance students' creative thinking skills in physics education? (2) How can the use of Virtual Laboratory media in the Case Based Learning model affect students' understanding of concepts in optics material? This research is expected to find effective solutions in the physics learning process in the classroom, so that learning goals can be achieved and physics learning becomes more interesting for students. Therefore, this research is titled "Improving Students' Creative Thinking Skills using the Case Based Learning Model with the help of Virtual Laboratory Media in Optics Material".

2. Method

Research method is basically a scientific way to obtain data for certain purposes and uses. In research, the use of appropriate methods is very important to achieve the expected results. Research method is a common strategy used in data collection to address the issues faced. In this research, the researcher used the Classroom Action Research (CAR) method with the Case Based Learning (CBL) learning model. Classroom Action Research (CAR) is a research on learning activities in the form of deliberately taken actions that occur simultaneously in a classroom [18]. Kunandar in Iskandar also stated that Action Research is an activity carried out by teachers or collaboratively with others to improve the quality of the learning process in their classrooms [19]. Therefore, Classroom Action Research (CAR) can be concluded as research conducted by researchers or teachers to improve the rational certainty of actions in carrying out tasks to meet what has already happened and done by the teachers.

The stages in the research according to Arikunto in Dadang Iskandar and Narsim are shown in Figure 1 [19].

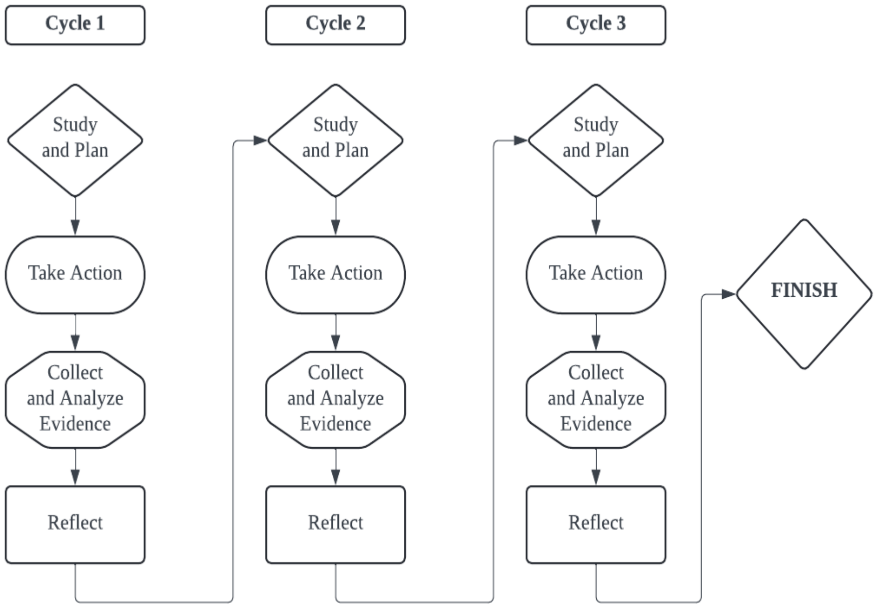

Figure 1. Action research flow.

This Classroom Action Research model refers to the model sourced from Arikunto in Dadang Iskandar and Narsim [19]. This research is carried out in cycles with four stages, namely planning, action, observation, and reflection. This research is conducted in three learning cycles, with each cycle consisting of one meeting.

The subjects of this research are students of class XI MIPA 6 at SMA Negeri 6 Kabupaten Tangerang in the academic year of 2023/2024, consisting of 41 students, with 21 females and 20 males. These students are divided into three groups according to each cycle of Classroom Action Research. Data collection was carried out from the fifth week of May 2024 until the first week of June 2024. The independent variable in this research is the Case Based Learning (CBL) learning model assisted by Virtual Laboratory Media, while the dependent variable is the results of students' creative thinking abilities on Optics material.

Table 1. Categories of creative thinking skills.

Percentage Range (%)	Category
81-100	Very Creative
61-80	Creative
41-60	Quite Creative
21-40	Less Creative
0-20	Not Creative

Data collection is carried out using evaluation tests and questionnaires at the end of each cycle. Creative thinking skills are measured using standard tests that assess various dimensions such as fluency, flexibility, originality, and elaboration. Assessment of creative thinking abilities is done in the form of learning tests and measured with questionnaires. The analysis method used is qualitative and comparative, comparing quantitative data of students' creative thinking abilities between cycles. Based on the total score calculation, the levels of students' creative thinking abilities are categorized as shown in table 1.

The calculation of students' creative thinking abilities as a whole is done by calculating the average results of the tests obtained and analyzing the level of students' creative thinking abilities. A student's creative thinking ability is considered to have reached the standard if the percentage reaches 81%.

3. Results and Discussion

The data was obtained from observations conducted during three cycles of learning to detect an increase in students' creative thinking abilities on the topic of Optics. Each cycle consists of four stages: planning, action, observation, and reflection. In the planning stage, a learning strategy using the Case Based Learning (CBL) model assisted by Virtual Laboratory was designed to maximize student engagement in the learning process. The action was then carried out according to the steps of the CBL model, which includes presenting cases, analyzing cases, finding information independently, solving cases, making conclusions, presenting results, and verifying answers.

The CBL model was chosen because it combines discussion methods with experiments, effectively encouraging the development of students' creative thinking abilities both individually and in groups. After completing three cycles of learning, students' creative thinking abilities were evaluated through tests conducted at the end of each cycle. The average calculation data of students' creative thinking abilities is presented in Table 2.

Table 2. Results of improving student's creative thinking skills.

No.	Category	Result Cycle I	Result Cycle II	Result Cycle III
1.	Very Creative	12,1%	29,2%	58,04%
2.	Creative	17,3%	22,9%	29,81%
3.	Quite Creative	19,5%	18,7%	4,84%
4.	Less Creative	26,8%	19,5%	7,31%
5.	Not Creative	24,3%	9,7%	0%

In the first cycle, the Case Based Learning model was used without the assistance of Virtual Laboratory and without student grouping. This contributed to unsatisfactory results, with only 12.1% of students (5 out of 41 students) achieving the "Very Creative" category (81-100%), and 24.3% of students (10 out of 41 students) in the "Not Creative" category (0-20%). Lack of motivation and student engagement in the learning process were the main factors affecting the low results in this cycle.

Moving on to the second cycle, student grouping into eight groups, each consisting of 5-6 students, was implemented, resulting in a significant improvement in creative thinking abilities. In this cycle, 29.2% of students (12 students) successfully achieved the "Very Creative" category. This grouping allowed students to discuss and help each other in solving problems that arose during Optics learning, making the learning process more effective and interactive.

In the third cycle, a more significant increase was seen with 58.04% of students (24 students) reaching the "Very Creative" category. This improvement occurred because the Case Based Learning (CBL) model was combined with the use of Virtual Laboratory, providing visualizations and simulations of abstract concepts in Optics. During the reflection stage, teachers asked analytical questions that motivated students to express their ideas related to the observed Optical phenomena. In this way, students not only understood the concepts being learned but were also able to discover new concepts based on observation and group discussions.

The visualization diagram related to the results of improving students' creative thinking abilities can be seen in Figure 2.

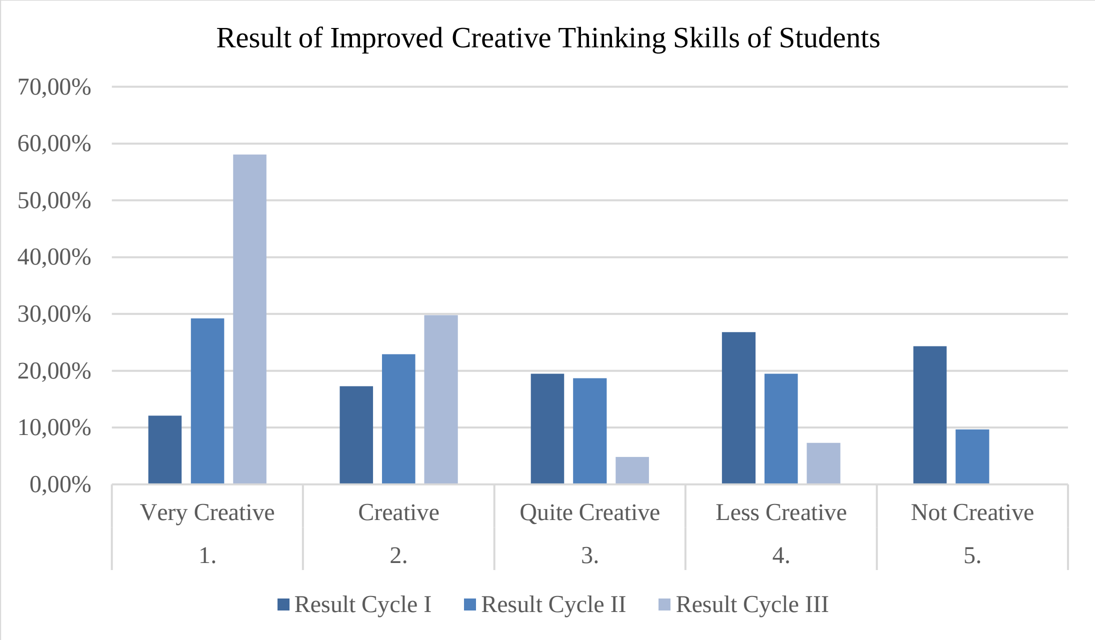

Figure 2. Result of improved creative thinking skills of students.

From this graph, it can be concluded that the program or intervention conducted during three cycles has a positive impact on students' creative thinking abilities. It is clear that the number of students falling into the "Very Creative" and "Creative" categories increased over time, while the number of students in the "Less Creative" and "Not Creative" categories decreased significantly. This indicates that the intervention was successful in enhancing students' creative thinking abilities. Scientifically, these results may reflect that learning that stimulates critical and creative thinking abilities can enhance these skills gradually. It also suggests that a supportive learning environment and innovative teaching approaches can encourage students to think more creatively.

The effectiveness of the CBL model assisted by Virtual Laboratory in improving students' creative thinking abilities can be explained through several factors. First, the CBL model promotes contextual and meaningful learning, where students can relate learning materials to real-life situations. Second, the Virtual Laboratory provides visualization tools that allow students to explore and understand abstract concepts that are often difficult to grasp through conventional teaching methods. Third, grouping students encourages collaboration, where students exchange ideas and solutions, thereby enhancing their critical and creative thinking skills.

Thus, the implementation of the Case Based Learning model supported by Virtual Laboratory proves to be effective in addressing the low creative thinking abilities of students. This combination of learning models not only improves learning outcomes but also provides students with a deeper and more meaningful learning experience, especially in understanding complex Optics material. This indicates that innovation in teaching methods and the utilization of technology can significantly improve the quality of education [20].

4. Conclusion

Based on the findings from three learning cycles in the classroom, the average creative thinking ability of students with the category "Very Creative" in the third cycle increased by 58.04%. The average score of creative thinking ability of students in the "Very Creative" category was initially low with an average of 12.1% and with the "Not Creative" category it had an average of 24.3%. So it can be concluded that there is an increase in students' creative thinking skills by using *the Case Based Learning* model assisted by *Virtual Laboratory* on Optical materials. For the development of the results of this study, it may be possible to do it by the next research, by conducting *a pre-test* before data collection. This is done to find out students' creative thinking skills mathematically and understanding physics concepts in daily life.

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