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# The Influence of PjBL-STEAM model toward students' problem-solving skills on light and optical instruments topic

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**Abstract.** One of the challenges of today's education in the disruption era is generating skillful, creative, and innovative human resources in solving problems. Therefore, a learning model to train students' problem-solving skills is required. The objective of this research is to analyze the influence of PjBL-STEAM toward students' problem-solving skills indicated by the average differences. The data were collected through test, documentation, and observation. The influence of the model was examined using a t-test. Further, the analysis showed that there was an average score difference between the students taught using the PjBL-STEAM and the students taught using the PjBL-scientific model by 3.495. In other words, the PjBL-STEAM model has a positive effect on the students' problem-solving skills.

## 1. Introduction

The disruption era is the time when society's mindset and behavior change. The competition of this era has been globally experienced so that strategies are needed to preserve viability[1]. In terms of education, one of the ways to survive is by ameliorating the educational system to master science, technology, and stimulate creativity. This can be done by generating skillful, creative, and innovative human resources in solving problems. Education has an essential role in children's maturity process both physically and[2].

Science and technology development of the 21st-century has been penetrated in almost all aspects of life, leaving a demand of competencies for the young generation. Transformation of learning has to be carried out to achieve the current educational requirements, which can be found in the 2013 Curriculum's principles. Having this curriculum implemented throughout Indonesia, it is expected to be able to generate faithful, productive, creative, innovative, and affective the younger generations. Moreover, Soulé & Warrick[3] stated that success in the digital era relies on the vital skills that include critical thinking, problem-solving, communication, and collaboration.

MTs Negeri 2 Brebes is a potential school to initiate students with the 21st-century skills particularly the problem-solving skills. The school has fairly applied the 2013 Curriculum yet could not enhance the students' critical thinking skills seen from the low score of the students in working on items containing indicators of critical thinking skills such as understanding problems and finding out solutions. Of all the students, there were only 30-40% of them answered the questions correctly.



The application of a suitable learning model is greatly influential on the output of learning. Güçlüer & Kesercioğlu [4] explained that the selection of a model or method should be adjusted to the student characters and the learning topic. One of the models that could explore students' critical thinking skills is Project-based learning (PjBL). It is a model that orients to projects (activities) as the core of the learning process. Sasson, et al. [5] revealed that PjBL has proven to enhance students' skills and creativity. This model, according to Ergül & Elif [6] will be much effective when links to everyday life science and technology. In complementing the PjBL model, an approach that could assist students in comprehending concepts, solve problems, and instill noble characters is greatly needed, and such an approach that suits the description above is the *Science, Technology, Engineering, Arts, Mathematics* (STEAM) approach.

The *Science, Technology, Engineering, Arts, Mathematics* (STEAM) is an approach that integrates science, technology, engineering, art, and mathematics in the learning process. The STEAM is a transformation of the other initial approach so-called the STEM by adding the art element in it. Referring to Watson & Watson [7], the principle of STEM and STEAM is pretty much the same, that it to grow innovation and creativity. The difference takes place on the art+design element, which is inserted to delve students' potential deeper than using the prior approach. This is in line with Henriksen [8] who elucidated that STEAM strengthens learning in all disciplines so that it enables students to explore and create connections between art, music, science, and so on.

The science learning process contains numerous topics that could be found in daily life and one of which is the topic of light and optical instruments which is taught in the VIII grade of junior high school. The topic owns several basic competencies which include describing the characteristics of light, the formation of light, the formation of image, optical instruments and their problems in everyday life. According to Saadah [9], issues related to daily life experience would allow students to understand and discover the solution.

Based on the explication, the researchers felt the need to research "The Influence of PjBL-STEAM Model toward Students' Problem-Solving Skills on Light and Optical Instruments Topic".

## 2. Methods

This is an experimental research that employed the Quasi Eksperimental method and Nonequivalent (Pre-Test and Post-Test) Control Group Design. There were two research subjects including the experimental (A) and control group (B). Each group experienced pre- and post-test yet only the A group was given treatment. The data were gathered through several methods comprising of documentation, method, observation, and test. The test was in the form of an essay that has been examined for the validity, reliability, and difficulty level. On the other hand, the observation was aimed to gather data displaying the real condition of the students during the learning process. The t-test was employed to examine the hypothesis of the PjBL.

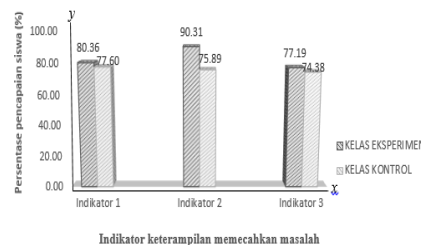
## 3. Results and Discussion

The PjBL-STEAM model was examined to unveil its influence on the students' critical thinking skills using the paired t-test whose results are presented in the following Table 1.

**Table 1.** The Results of Paired T-Test on the Problem-Solving Skills

Data	Class	S <sup>2</sup>	T <sub>count</sub>	t <sub>table</sub>	Information
Problem-Solving Skills	Experimental	42.923	3.495	1.99	H <sub>0</sub> is rejected due to the existence of the average difference
	Control	80.951			

Table 1 shows the paired t-test data of students' problem-solving skills having  $t_{\text{count}} \geq t_{\text{table}}$  (in the rejection area of  $H_0$ ), then, it concludes that the PjBL-STEAM affected the students' problem-solving skills seen from the average score difference between the experimental and control class. The percentage of the student scores is displayed in Figure 1.



**Figure 1.** The Score of Each Problem-Solving Indicator

Figure 1. explains that the students in the experimental class have better problem-solving skills than those in the control class. Based on the results, it appears that the PjBL-STEAM has affected the problem-solving skills, which according to Tambunan [10], comprise several indicators including (1) understanding a problem, (2) arranging and performing problem-solving steps, and (3) re-checking the problem-solving results.

The model's stages are believed to impact the problem-solving skills. The first stage is *starting with essential questions*, where each student was given a problem related to light and optical instruments then solved through a project. The first indicator of problem-solving skills, i.e. understanding a problem, was trained in this phase. As presented in Figure 1, the students of the experimental class got a higher score than the control class for the first indicator. Moreover, Perignat & Katz-Buonincontro [11] stated that the STEAM approach integrated with the syntax of the PjBL model could motivate students to answer challenging questions and work on complicated problems.

The next stage is the *project design* where the students create a project by collaborating with the STEAM elements. It was observed that the students employed the technology element in the form of internet usage in seeking references and camera usage for documentation. Moreover, the students applied the engineering element that explains the way or technique for making and using the project. The art was seen to be implemented by adding figures or colors. Further, the students calculated and measured the required component of the project.

The second indicator of problem-solving, i.e., arranging and performing problem-solving steps, was trained during the implementation of the PjBL model at this stage. Along with the group members, the students set up plan and finished the problems accordingly to the established plan [12]. The students made use of common materials which were managed simply to make it easy for the students to understand. It is parallel with Wusqo [13] that learning with a simple project could be comfortably received, remembered, and comprehended compared to when conducting laboratory testing.

The difference between STEM and STEAM is the replenishment of art to stimulate innovations as art is free and unrestricted [8]. The art is poured in the form of the project design, which may boost creative ideas to find the solution of problem [14]. In addition to innovation, the insertion of figures and color combination will escalate the artistic value. In other words, the PjBL-STEAM model in the design project stage could train the second indicator of problem-solving skills.

As presented in Figure 1, among the three indicators, the most remarkable increase was in the second indicator which scored higher than the control class. The PjBL-STEAM model could encourage the students the work collaboratively in looking for solutions. As Ridwan *et al.*[15] stated, the use of the PjBL-STEAM model would grow cooperation, communication, and self-management in solving problems.

The next stage, *monitoring the students and progress of projects*, allows the teacher to watch over the project making process. At this phase, the students have to report every project development. The

students could examine the mistakes they made and get feedback from the teacher before presenting and demonstrating the project in front of the class. This stage was less favorably conducted due to time limitations since the PjBL-STEAM requires quite a long time to apply. Similarly, Nurita [16] stated that a project done uncontrollably would be hard to implement and evaluate, this would also have an impact on the third indicator of problem-solving skills (re-checking the problem-solving results).

Referring to Figure 1, the least score of the problem-solving indicator was in the re-checking of the problem-solving results. The results showed that the students remained to find it difficult to re-examine the obtained results. This was also observed during the learning process of the PjBL-STEAM model at the stage of *assessing the outcomes and evaluating the experience*. This is the last phase which includes project presentation, demonstration, assessment, and evaluation.

During the presentation, some of the students' products experience malfunctions. This indicated that the students have not been able to examine the learning process and the obtained results as they focused only on finishing the project. They should have been more patient and concerned to avoid the malfunctions. Further, Jacques et al. [17] science, technology, engineering, art dan mathematics stated that students need to re-check their problem-solving results. This is in line with Shieh & Chang [18] who confirmed that re-evaluation of the process and answer is immensely essential to correct mistakes.

The research results revealed that the experimental class obtained higher scores of three problem-solving skills indicators due to the application of PjBL-STEAM as it has several advantages that include (1) training students to think about the steps they will take to solve a problem; (2) creating a product containing the element of *science, technology, engineering, art, and mathematics* to make interesting and enjoyable learning and at the same time stimulating creativity; and (3) upskilling students' verbal and written communication. Correspondingly, Ridwan *et al.* [15] research unfolded that STEAM with project-based learning could develop learners' soft skills.

#### 4. Conclusion

Based on the explained research results and discussion, it concludes that learning with the PjBL-STEAM model on the light and optical instruments affected the students' problem-solving skills, observed from the score differences between the experimental and control class.

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