PjBL-BASED BLENDED LEARNING IMPLEMENTATION ON ENERGY TOPIC TO IMPROVE THE PROBLEM-SOLVING SKILL

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ABSTRACT

Blended learning is a new strategy or way in the learning process. Besides face-to-face learning, the learning process should also be carried out in an online manner. Online learning could facilitate teachers and learners to learn anywhere and anytime. It is an appropriate learning strategy and supported by a learning model that could integrate various science disciplines, such as science, technology, engineering, and mathematics. This research aims to describe the improvement of problem-solving skills on energy via blended learning-based PjBL STEM. Each syntax of the learning consists of five-stage. They are problem solving, focus the problem, describe the problem in physics description, plan a solution, execute the plan, and evaluate the solution. This research applied an experimental research design with pre-experimental (one group pretest-posttest design). The sample consisted of thirty-five Al-Azhar Islamic SHS 3 Bandar Lampung at X Science 1. The instrument was a problem-solving skill test in the form of an essay. The test results were analyzed with paired sample t-test. Based on the promoted research, the N-gain of experimental group learning outcome was 0.43, categorized moderate. The paired sample t-test hypothesis result obtained the Asymp. Sig (2-tailed) ≤0,05 is 0,00. It showed the improvement of problem-solving skills using the blended-learning-based PjBL STEM model.

INTISARI

Blended learning is a new strategy or way in the learning process. Besides face-to-face learning, the learning process should also be carried out in an online manner. Online learning could facilitate teachers and learners to learn anywhere and anytime. It is an appropriate learning strategy and supported by a learning model that could integrate various science disciplines, such as *science, technology, engineering,* and *mathematics.* This research aims to describe the improvement of *problem-solving* skills on energy via *blended learning*-based PjBL STEM. Each syntax of the learning consists of five-stage. They are *problem solving*, *focus the problem, describe the problem in physics description, plan a solution, execute the plan, and evaluate the solution.* This research

applied an experimental research design with *pre-experimental* (*one group pretest-posttest design*). The sample consisted of thirty-five Al-Azhar Islamic SHS 3 Bandar Lampung at X Science 1. The instrument was a *problem-solving skill* test in the form of an essay. The test results were analyzed with *paired sample t-test.* Based on the promoted research, the *N-gain* of experimental group learning outcome was 0.43, categorized moderate. The *paired sample t-test* hypothesis result obtained the *Asymp. Sig* (*2-tailed*) ≤0,05 is 0,00. It showed the improvement of *problem-solving* skills using *the blended-learning*-based *PjBL STEM* model.

I. Introduction

The 2013 curriculum is perceived relevant with the 21st-century development in which the learners are demanded to have problem-solving skills. The problem-solving process requires an accurate approach to reach 21st-century reliability.

According to Matlin (1989), cited in [1], an individual requires problem-solving to reach his objectives. However, the objective has not been reached. Heller & Heller (2010) found some indicators of problem-solving [2]. They focus on the problem, describe the problem in physics description, plan a solution, execute the plan, and evaluate the solution.

The innovation in learning implementation could be realized in STEM education [3]. Trianto (2014) defines STEM (Science, Technology, Engineering, and Mathematics) as the scientific discipline that is inter-connected [4]. STEM learning provides opportunities for learners to solve problems. It also provides the freedom to design the solution so they will easily remember and master the technology.

However, in a learning activity, the problem-solving skill of learners was low because the learning process frequently had misunderstandings while learning physics [5]. Learners assume that physics is difficult material because it has many concepts [6].

The interview with the physics teachers of the school proved that physics learning on energy topics was merely transferring knowledge. Thus, the problem-solving skill was low. One of the efforts to improve the problem-solving skill was providing them conceptual meaning for the learners to learn and connect with daily life problems [7].

Therefore, learners need to make a simple project from the easily found materials in daily life. The project can be creating a mini solar water heater as the practice to apply physics concepts about energy. The energy topic is applicable in STEM-based learning.

One of the teachers' roles in the learning process is to select the applicable learning approach for their classes [8]. Learning approaches and models that can be integrated with physics-based on the education objectives, using daily life problems, is the learning-based PjBL STEM model [9]. PjBL STEM is a model in the learning

process via project activity [8]. PjBL STEM could improve the learners' interest, create more meaningful learning, and train learners to be problem-solvers in real life [10].

This research aims to find out the influence of blended learning-based PjBL STEM on the learners' problem-solving skill improvements on energy topics. The use of blended learning was due to the COVID-19 pandemic outbreak. Therefore, blended learning was a new way for the learning process.

II. Research Methodology

This research used a quasi-experimental method. The applied research design was pre-experimental (one group pretest-posttest design). This design provides a pretest before the treatment. Then, the research must analyze the results [11].

The research population covered all X science students of Al-Azhar 3 Bandar Lambung. They were distributed into five classes: X Science 1 until X Science 5. The sampling technique was simple random sampling. The sampling technique required the researchers to provide equal opportunities for the population to be selected as a sample. The result was a sample class, the X Science 1. It consisted of 35 learners.

The problem-solving of the learners was measured based on the worksheet outcomes and pretest-posttest answers of learners. The instruments were syllabus, lesson plan, STEM-based worksheet, and interview instrument of need analysis. The interview consisted of the guided interview guideline and the problem-solving intention test instruments. The test consisted of seven essay questions.

The researchers analyzed the obtained data with IBM SPSS Statistics software version 20.0. The normality test was to determine whether the data were normally distributed or not. The hypothesis test was paired sample t-test to determine the existence of problem-solving skill gain of the learners. The N-gain was to check the pretest and posttest score differences of the experimented group.

III. Results and Discussion

The frequent occurring mistakes were sub-scripts on the permeability quantity of vacuum space, such as its writing style that should have been written with the digit 'zero' instead of "o'" The prefix of the foreign term "non" should not have been separated with the following word. The results showed the improvement of the learners' problem-solving skills that were analyzed with N-Gain. The N-Gain data is in Table 1.

Tabel 1. The N-Gain average of problem-solving skills

Score achievements	Experimental group
The highest gain	0,75
The lowest gain	0,10
The gain average	0,43
The score increase average	43%
Category	Moderate

Table 1 shows that the experimental group's N-gain is categorized as moderate. Then, the data normality test was used to find out whether the data were normally distributed or not. The normality test could be seen in Table 2.

Tabel 2. The normality result of the problem-solving skill N-Gain

Groups	Kolmogorov Smirnov Sig.	
	Pretest	*Posttest*
Experimental group	0,428	0,657

The table shows the significant value of the experimental group's N-gain is normally distributed with Asymp. Sig (2-tailed) higher than 0,05. The test results show that the problem-solving skill scores of the class are normally distributed. The result met the requirement to conduct paired sample t-test.

The normality data test shows the N-gain of the experimental group is normally distributed. Therefore, the research used paired sample t-test hypothesis test. The results of the hypothesis test are in Table 3.

Table 3. The Learning Outcome Hypothesis Test Results

	Sig. (2-tailed)
pretest-posttest	.000

The table shows the Asymp Sig (2-tailed) ≤0,05. Therefore, H0 is denied but H1 is accepted. It meant the experimental group had the N-gain average differences.

The results were the problem-solving skill achievements based on the indicators of the worksheet assessment (Figure 1).
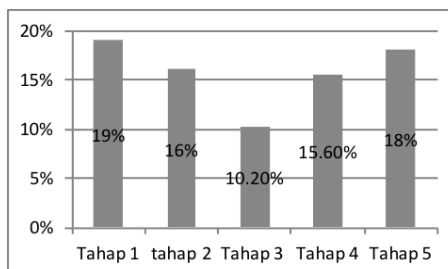

Figure 1. The problem-solving skill achievement for each indicator was based on the worksheet assessment.

Figure 1 shows the highest problem-solving skill indicator achievement for each group was in the first stage (the focus of the problem). The second stage, describing the problem in physics description, reached a percentage of 16%. The third stage, planning the solution, reached a percentage of 10.20%. The fourth stage, executing the plan, reached a percentage of 15.60%. Then, the fifth stage, evaluating the solution, reached a percentage of 18%.

Besides that, the quantitative data showed the differences between pretest and posttest scores of the experimental group. It proved there was an increase due to the applied learning with a score of 25.8. The data are in Table 4.

Table 4. Quantitative data of the learning outcomes

Statistics parameter	Pretest	Posttest
The sample number (N)	35	35
The highest score	59,4	88
The lowest score	21,4	33,2
The maximum score	100	100
The average score	41,3	67,1

Table 4 shows the experimental group's problem-solving skill average before and after the intervention. It shows a significant improvement.

The improvement was caused by the problem-solving skill training of the learners due to the STEM-based PjBL model implementation [12]. The paired sample t-test was accepted H_1 with a significant score $< 0,05$ of 0.000. It meant there was an improvement of the skill taught by blended learning-based PjBL STEM. From the result, the learners' problem-solving skills had improvements although the N-Gain average was 0.43, categorized moderate.

In this research, the researchers adopted all research stages from the beginning until the evaluation of the PjBL STEM model [13]. This research was carried out for the even-semester learners in the academic year 2020/2021. Here are some explanations about the research model. They are

Reflection, This stage brought learners to the problem context of real-life or real structure [14]. In this research, the researchers researched an online manner via WhatsApp group. The trained problem-solving skills are: focusing on the problem means stimulating learners to pay attention, review, think about problems, and analyze the problems to solve [15].The skills can be observed in the worksheet answers shown in Figure 2.

After observing the phenomena and watching the presented videos, answer these questions:
1. What physics concept do you know?
   The energy conservation law. The given phenomenon is the sunlight energy conservation into heat.
2. Is there any energy conservation? If you think so, please explain!
   It is. The solar water heater has a sunlight catcher. The caught energy is conserved into heat.
3. What can you argue about the solar water heater as one of the developed technological uses to obtain water with higher temperatures?
   The solar water heater is a developed technology that uses solar energy. Thus, it is environmentally friendly.
4. Can you tell the sunlight energy uses as the material to create a solar water heater?
   The sunlight is caught by the screener. It is a collector that collects the heat. The screen is painted black to catch the high-temperature lights. The sunlight energy is conserved into heat and this heat energy is used to heat the water inside the collector.

Figure 2. The learners' answers on the worksheets

Research, Learners collected the relevant information based on the products. In this research, the researchers researched an online manner via WhatsApp group. Together with their teams, they sought the information to obtain the most relevant concept that would be used. They did it by using the Internet. By researching, the learners were trained properly via problem-solving skills with describing the problems in physics description indicators. The skills can be observed in the worksheet answers shown in Figure 3.

Based on the physics video, the most relevant matter of the video was the sunlight energy conversion into heat.
The device mechanism is to use the solar panel installed on the roof to receive the direct sunlight heat. It functions to collect the heat for heating the water.
The water heating process consists of a component called a cylinder. It stores the heated water to be flown via pipe installation.

Figure 3. The learners' answers on the worksheets

The figure shows learners could interpret and describe the problems based on information related to the problems [16].

Discovery, This stage mediated the research and the recognized information in arranging the products. Thus, learners could cooperate. In this research, the researchers researched an online manner via WhatsApp group. The trained problem-solving skills are: Planning a solution. The learners designed the problem-solution that they described previously. Here are the solution designs or sketches about the mini solar water heater (Figure 4).
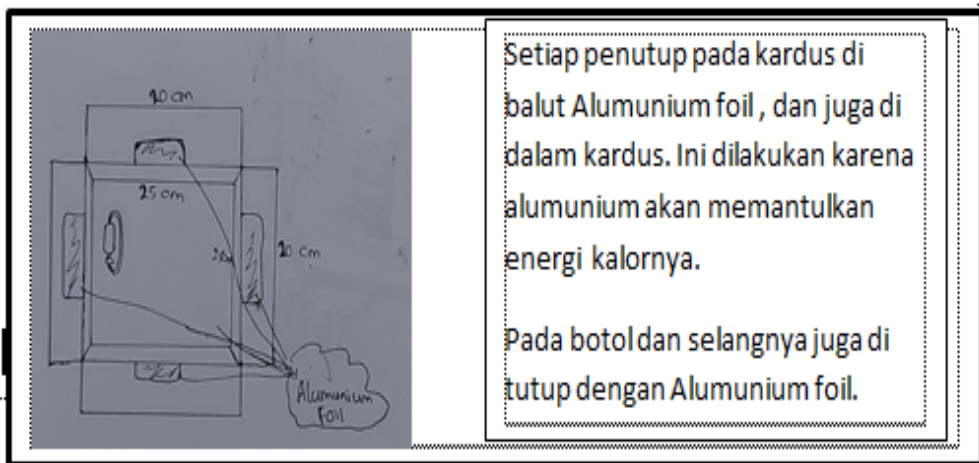
Figure 4. The learners' sketches about the mini solar water heater.

The figure shows learners planned the solution of the described problems previously by designing the product. According to Caporo et al (2013:29), it was in line with the *STEM PjBL* characteristics that emphasized the designing process [10]. This process is a systematic approach that develops solutions to the problems.

Application This stage aimed to create and test the product or solution to solve problems by using the obtained results to revise the solution. This research stage required the researchers to do it offline at school. Here is one of the learners' activities while constructing and examining the trial of a mini solar water heater (Figure 5).

Figure 5. The activities and the learners' learning products

The learning activities in Figure 5 integrate some science disciplines. They were science, technology, engineering, and mathematics. Dewi, Kaniawati, & Suwarna (2018) found that the science discipline integration could train the problem-solving with the indicator of Executing the plan [7]. The learners were trained to use the already made design, to determine the tools and materials, to measure mathematically for each product part correctly, and to examine the product based on the obtained concept.

Communication. This stage was the final stage. It dealt with communicating the products for the classroom environment. This stage was done via Zoom online. The learners' di d an evaluation in the form of conclusion. They also compared their results with the other groups' results with different answers or findings. With this activity, learners would collaborate and be active in sharing and communicating the solution excellently [17]. The attitudes were the actualization of problem-solving indicators exactly about evaluating the solution.
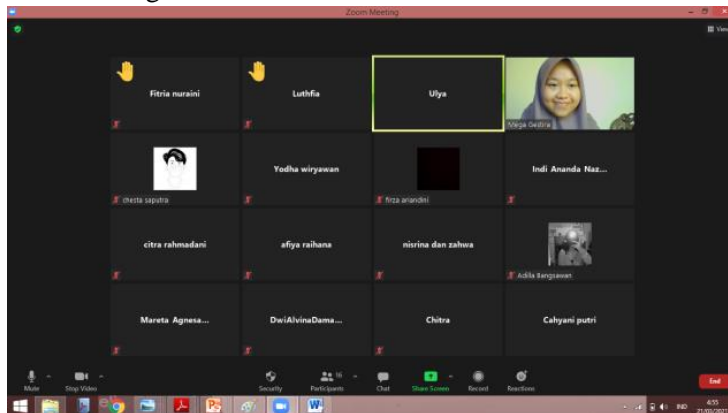

Figure 6. The presentation of the applied experiment

IV. Conclusion

Based on the research result and discussion, the applied blended learning-based STEM PjBL could improve the learners' problem-solving skills on energy topics. The applied model for learning physics is important especially the psychomotor aspect (CC 4). Thus, the teachers and learners would be easy to determine the product and test it The blended learning strategy for learning physics can be the learning alternative because it can be done in a face-to-face manner or electronically anywhere and anytime. The product trial proved the research had limitations. The rainy weather became a hindrance for this project. Thus, this research recommends a second plan to ensure the product trial runs.

Acknowledgment

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