Implementation of Project Based Learning Based on STEM Approach to Improve Students’ Problems Solving Abilities

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Abstract. This study aims to analyse the improvement of the problems solving abilities by implementing project-based learning with a STEM approach using a distance learning strategy. This research method is a pre-experimental pretest-posttest one group design. The population of this research was the 5th-grade students of Magelang Elementary School in 2019/2020. The sample selection using purposive random sampling with 78 students. The research subjects were elementary school students with symbols A, B, C, and D located in several areas of the City of Magelang, Central Java. Data collection techniques used in this study are tests of problem-solving ability and observation. Quantitative data analysis techniques used were gain normality test and one-sample t-test. The results showed that the problem-solving ability of students increased significantly with a gain factor is 0.44 (enough), a one-sample t-test with a sig (2-tailed) is 0.121 (significantly) and the results of observations of the implementation of learning are 92% (very good). In other words, the project-based learning based on STEM approach with distancing learning strategies could significantly improve students’ problems solving abilities.

1. Introduction
Entering the 21st century, many abilities must be mastered by students in facing every challenge of life's problems. The era of technological development is increasing global competition is getting tougher [1]. So that education is expected to be able to prepare students to live their lives in the future and use of a four-factor structure to measure student attitudes toward science, math, engineering/technology, and 21st century skills [2]. The abilities needed in the 21st century are also contained in the Regulation of the Minister of Education and Culture Number 21 of 2016 concerning Content Standards and Educational Standards, namely communication skills, problem-solving, critical thinking, creativity and innovation, and collaboration. This ability must be possessed by students in Indonesia to meet future needs and to welcome the golden generation in 2045.

The ability to solve problems is an ability that cannot be avoided from human life and also influences human survival. These research also correlation with the investment in building STEM integration capacity with a specific focus on sciences content can offer a model for STEM integration that challenges in professional development, encourages instructional leadership, and promotes sciences readiness for carrier [3]. In this case, the brain makes maximum use of its cognitive function. This function includes analytical thinking, synthesizing, generalizing in solving problems that involve critical thinking processes, reflective thinking, decision making and scientific methods. As for STEAM effects on student learning, a number of meta-analyses showed that students’ experiences with STEAM were effective in both cognitive and affective learning [4]. They expressed the view that students’ immediate environment, everyday life, and exposure to technology augmented their science learning while their
Problem-solving abilities are part of the mental and intellectual processes carried out by students to connect prior knowledge with the problem at hand, remembering the experience of solving problems that existed in the past and then getting solutions to the problem at hand [6]. In another opinion, the problem-solving ability is the process of identifying gaps between issues and solutions using science and reasoning [8].

To resolve the issue, the students have to pass through five stages. The steps are (1) Define (2) Assess (3) Plan (4) Implement (5) Communicate [7]. If students have good problem-solving skills, problems that arise will be well resolved [8]. In facing global competition, need problem-solving skills. It takes various efforts to improve problem-solving abilities in students. Students are expected to face problems so that they can adapt when deployed to community efforts that can do one of them is to improve the capacity and quality learning process in the class. Learning methods have adapted to the characteristics of today's students. Thus, students will be trained and ready to take part in real-life [9].

However, based on observations and short tests conducted at the Magelang City Elementary School, there is a finding that the problem-solving ability is still low. Research in line that was works [10].

Entering the beginning of 2020, Corona Virus Disease, or known as Covid-19 has spread to Indonesia. Education, government, educational institutions, teachers, and others apply to distance learning. Distance education is a teaching and learning process that is carried out remotely through various communication media [11]. With this COVID-19 application of project-based learning with the STEM approach, it must also be carried out by e-learning. Implementing educational policies in the emergency period of the spread of the coronavirus disease (Covid-19) is carried out with distance learning. Implementing e-learning also takes into government instructions by implementing the KTSP (Kurikulum Tingkat Satuan Pendidikan) as an emergency curriculum. Using learning models combined with e-learning expect to be an alternative in distance learning.

In implementing distance learning strategies it must combine with learning models that can improve problem-solving skills. One of the learning models that apply by online learning is Project-Based STEM Learning, that the teachers’ support was personal and caring in an environment of high expectations was crucial for student success. Three critical elements of the teachers’ supports and challenges consisted of student-centred projects, a focus on twenty-first century competencies, and strong teacher-student relationships [12,13]. Project-Based Learning when combined with STEM will improve problem-solving skills. Project-Based Learning is a learning model relevant to global demands in the 21st century [14]. In science learning, project based learning trains students to work on problems in the world. In this lesson, students will be involved in small groups and seek solution options where the teacher acts as a facilitator. These findings also highlight the importance of encouraging students’ participation in both formal and informal STEM activities [15].

Thus, problem-solving competencies are very important in implementing the project. Problem solving competence means involving students in solving problems using different strategies, from multiple perspectives and with various modalities [16]. Projects in project-based learning can combine by integrating Science, Technology, Engineering, Mathematics. To integrate STEM into learning, activities focused on project creation carry out in the classroom. Themes related to project creation can teach the concepts of history, science, facts, knowledge, the nature of science, and to practice problem-solving and critical thinking skills [17]. Therefore, STEM integrated Project Based Learning expects to improve students' problem-solving skills.

Project-Based Learning is a model that presents a problem related to the concept to students and allows students to carry out experiments or investigations. The PjBL model provides an opportunity for students to apply their knowledge to solve problems [5]. Indirectly, the PjBL model also encourages students to master the knowledge needed to solve these problems [18].

The STEM approach is learning by integrating Science, Technology, Engineering, and Mathematics [7]. The application of STEM in learning can encourage students to design, develop, use technology, hone cognitive, manipulative, effective, and apply knowledge [19]. Thus, STEM learning is suitable for
learning in elementary schools. STEM-based learning can train students to apply their knowledge by making designs as problem-solving related to the environment by utilizing technology and mathematics as measuring tools [7]. According to Bybee, STEM is related to the importance of science and mathematics in technology and engineering [20]. Integrating STEM in the PjBL learning model can improve problem-solving skills in real life. Thus, it is possible to use the STEM approach to improve students’ problem-solving skills. The research in line, that STEM education is a universally crucial tool which effectively prepares students from various national and cultural backgrounds, across Asia, toward improved learning outcomes [21].

2. Methods
The research design used a pre-experimental design (pre-experimental design) with the Pre-Test Post-Test in one group design). One-Group Pre-Posttest Design is a design that includes one group that observes at the Pre-Test stage, which is then followed by treatment and ends with a Post-Test. The dependent variable in this study is the student's problem-solving skills. While the independent variable in this study is a project-based learning model. The population in this study were all grade 5 in 4 selected schools in Magelang City, Central Java, who register in the even semester of the 2019/2020 school year. The sampling technique in this study was purposive random sampling. The total sample size in this study was 78 students.

The problem-solving skill instrument used was a test. The problem-solving skill test gives in two trials, namely the pretest and posttest in the problem description questionnaire which comprised 5 structured items. Each item comprises five problem-solving indicators which refer to the problem-solving indicators according to Meier where there are five problem-solving steps (1) Define (2) Assess (3) Plan (4) Implement (5) Communicate [22].

Before doing the research, the instrument was validated and tested first. The instrument test carries out by three experts. After the data collected, the score of problem-solving ability from the pretest and posttest obtain by calculating the average N-gain and one-sample t-test.

3. Result and Discussion
Before implementing learning, the researcher designed a learning process with a distancing learning strategy by setting a learning implementation plan, teaching materials, worksheets, and problem-solving skill test evaluation. Distancing learning strategy uses a variety of learning media using Microsoft Sway Office as a support for online teaching materials, Google Form as support for worksheets, and two-way communication which carries by utilizing zoom meetings and WhatsApp groups.

After all the instruments are made, then trial questions and instrument validation carry out to the experts. Trial questions need to measure whether the instrument is valid and reliable. Meanwhile, expert validation is lecturers, teachers, and postgraduate students to determine whether the instrument is suitable for use. The results of the test questions stated that all the questions made proved valid and the reliability test showed a Cronbach's Alpha score of 0.913 while a table of 0.2480 meant that the questions were reliable. If all the precondition is met, then research can carry out. In implementing learning, researchers asked colleagues to observe the implementation of learning. The result shows a very high score of 92%. Problem-solving skills data obtain from the pretest and posttest scores. The pretest and posttest scores was presented in Table 1.

| Data     | N  | Ideal Score | Min Score | Max Score | Average Score | Criteria   |
|----------|----|-------------|-----------|-----------|---------------|------------|
| Pretest  | 78 | 100         | 57        | 76        | 66            | Sufficient |
| Posttest | 72 | 91          | 81        |           |               | Good       |

The problem-solving skills test is giving at the beginning of the initial meeting and the final meeting. The problem-solving skills test results per indicator was presented in Table 2.
Table 2. Achievement of Problem Solving Skills Results

| Indicator | Posttest Score (%) | Criteria | Pretest Score (%) | Criteria |
|-----------|--------------------|----------|-------------------|----------|
| Define    | 1038               | 88       | Good              | 882      | 75       | Good    |
| Asses     | 946                | 80       | Good              | 790      | 68       | Sufficient |
| Plan      | 928                | 79       | Good              | 772      | 66       | Sufficient |
| Implement | 880                | 75       | Good              | 724      | 62       | Sufficient |
| Communicate | 945             | 80       | Good              | 711      | 61       | Sufficient |

Based on Table 1 and Table 2, shows that the achievement of problem-solving skills simultaneously has an increase from pretest to posttest. The Define indicator has increased from a score of 882 (75%) to 1039 (88%) with good criteria. The Asses indicator has increased from a score of 790 (68%) to 946 (80%) with good criteria. The Plan indicator has increased from a score of 772 (66%) to 928 (79%) with good criteria. Implement indicators have increased from a score of 724 (62%) to 880 (75%) with good criteria. The Communicate indicator also increased from 711 (61%) to 945 (80%). Based on these data, it can conclude that learning to use an integrated STEM-based project-based learning model based on distancing learning can affect students' problem-solving abilities.

The results of the N-gain test showed results 0.44 in the moderate category. This proves that the use of STEM integrated project-based learning model based on distancing learning can improve learning outcomes in the form of problem-solving abilities. This research was supported by using linear regression analysis showed that school and out-of-school participation in STEM activities significantly predicted the students’ self-efficacy in STEM activities, while grade and gender did not [15]. Furthermore, the t one sample test with the help of the SPSS version 20 program. This test uses to prove a significant increase in the problem-solving skills test by comparing the standards score of the school's science subject, which is 75. The results of One-Sample T-Test was presented in Table 3.

Table 3. One Sample T-Test of Problem Solving Scores

| Standards score = 75 |
|-----------------------|
| t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference |
|---|----|-----------------|-----------------|------------------------------------------|
| Posttest_TK PM       | 13.479 | 77          | .121            | 5.949            | 5.07          | 6.83          |
After seeing the improvement of each indicator, an N-gain test is also needed to see the results. The results of the N-gain test show the results at 0.44 included in the medium category. The last is to analyze the results of the one-sample t-test and the results are 0.000, thus the increase shows a significant result for less than 0.05. The increase in the results of problem-solving skills in the moderate category cause by several factors. Likewise, only four lessons implement. So that the results are not optimal. The application of STEM in learning activities can train students' skills in developing creativity, critical thinking, collaboration, communication (4C), and problem-solving so they can find solutions faced in real life and be able to convey well [22]. Integrating STEM with the Project-Based Learning model can develop problem-solving skills in students. STEM is an educational model that provides the knowledge and skills needed for the 21st century. The STEM makes a learning model that provides the knowledge and skills needed in the 21st century, one of which is problem solving [23].

4. Conclusion
The skills to solve problems increase by applying the STEM integrated project-based learning using a distancing learning from an average of 66% to 81%. The N-gain of the problem-solving skills test was 0.44 (moderate), the one-sample t-test was 0.121 which meant that the increase was significant and the results of the observation of learning implementation were 92% (high). If it is concluded, implementing STEM integrated project-based learning using a distancing learning strategy can improve problem-solving abilities.

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