Modified Student Activity Sheet and Improving Problem Solving Skill

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Abstract: Mastery of 21st Century Skills by pre-service teachers is a necessity. Problem Solving skill is one of them. This study aims to obtain an overview of problem-solving skill in the Basic Physics course after getting the learning by using Student Activity Sheet (SAS) with Problem Based Learning (PBL). This research method uses quasi experimental with one group pretest-posttest design. The sample in this research is 30 pre-service biology teachers in West Java taking a basic physics course. The result of research indicates that application of SAS with PBL can improve student's problem-solving skill. This research recommends applying this model to other courses.

1 INTRODUCTION

There is a shift in output and learning outcomes in the 21st century. Learners are not only required proficient in mastering the concept but must master the seven other skills: technical, information management, communication, collaboration, creativity, critical thinking and problem solving (van Laar et al., 2017). The seven skills must be learned and practiced in everyday life especially in the learning process (Trilling and Fadel, 2009). These skills will be discussed, harvested and rewarded in higher education (Egan et al., 2017). Various efforts to improve these skills have been conducted in various ways such as game-based learning (Qian, and Clark, 2016), critical thinking models (ŽivkoviĿ, 2016) and have been integrated into science learning (Duran et al., 2011) and technology (O'Neal et al., 2017).

One of the 21st century skills that are being promoted in the world of education today is the solvency of problem-solving (Rodzalan and Saat, 2015). Almost all science subjects in school are directed to it, including physics. Even physics is identic with problem-solving (Bascone et al., 1985). Previous findings suggest that most students can easily receive knowledge of physics, but it is difficult to apply their knowledge flexibly in solving problems (Larkin, 1980). The ability to solve problems is not an innate ability but empowered when students have the opportunity to do so (Shute and Wang, 2015).

One effort to develop student problem-solving skills is through approaches, models, methods and instructional media that facilitate the creation of problem-solving skills. One of the learning models that is oriented to problem solving/real-world problem is problem-based learning (PBL). PBL is one of the effective learning models in teaching problem-solving skills, supporting active, dynamic, and varied learning (Martin, 2003). In practice, PBL provides an attractive framework for learners and teachers in careful planning and preparation (Caesar et al., 2016; Sadlo, 2014). Usually, educators present problems based on authentic and unstructured experience, while solutions to these problems are derived based on deep learning experiences (McComas, 2013).

The PBL in this study is applied to a modified Student Activity Sheet (SAS). SAS that has been used in schools is considered not enough to facilitate the achievement of problem-solving skills. The role of the teacher as a facilitator is the key to the successful use of SAS (Herman and Yusuf, 2016; Sari and Wijaya, 2017). The use of SAS with PBL model is expected to train and develop student problem-solving skills. The purpose of this study is to find out the improvement of student problem-solving skills after obtaining learning with the PBL model with the help of modified SAS.

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2 METHODS

This research is a pre-experimental using one group pretest-posttest design. Research subjects in this study are biology teacher candidates in West Java who take the Basic Physics course amounting to 30 people. Data collection in this study was obtained through the problem-solving skill test instrument. Meanwhile, the improvement of problem-solving skills is obtained from the N-Gain pretest and posttest values. Characteristics of problems used in the form of real-world problems that are open (open problem) to enable the emergence of a variety of answers. The problem indicators include five indicators of problem-solving skills, namely a) useful description); physics approach; c) specific application of physics; d) mathematical procedures); and e) logical progression). The scoring guidelines in this study adopted the scoring guidelines for problem-solving skills developed by Docktor (2009).

The improvement in this research is the change of problem-solving skill between before and after learning with PBL model expressed in normalized score gain average ($< g >$). The normalized gain value of a treatment according to Hake (1998) is defined as the actual average gain ratio $< G >$ with an average maximum gain $< G >_{max}$ as expressed in equation (1):

$$<g> = \frac{\%<G>}{\%<G>_{max}} = \frac{(\%<S_f> - \%<S_i>)}{(100 - \%<S_i>)} \quad (1)$$

Where $< S_f >$ and $< S_i >$ are the final (post) and initial (pre) class averages. The value ($< g >$) is then interpreted into the classification in table 1.

Table 1: N-Gain classification.

N-Gain	Classification
$(< g >) \quad < 0,3$	low
$(< g >) < 0,3 \leq 0,7$	medium
$(< g >) \quad > 0,7$	high

3 RESULT AND DISCUSSION

3.1 Problem Solving Skill Improvement

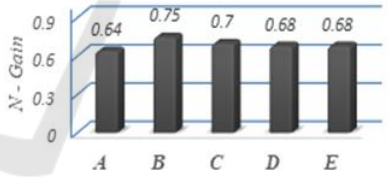
Measurement of problem-solving skills can be done in various ways such as Nonverbal Indexes of Students' Physical Interactivity (NISPI) conducted by Cukurova et al. (2018) or through stealth assessment (Shute et al., 2016). In this study, the measurement of problem-solving skills is done through a problem-solving test instrument whose problem-solving skill indicator is adopted from Jennifer Docktor's assessment rubric.

Based on the results of recapitulation and data processing problem-solving skills from all samples obtained information that the average pre-test is 22.09, the average post-test is 75.09 and the maximum value that can be obtained is 100. Referring to the formula in equation 1, the average value N-Gain for all student answers is 0.68 (medium category). This suggests that the use of modified student activity sheets on problem-based learning can facilitate students in sharpening their problem-solving skills.

In addition to learning in the classroom, efforts to improve problem-solving skills can also be done with online games (Hooshyar et al., 2016) and digital games (Ruggiero and Green, 2017). Problem-solving skills are not only directed at students, but prospective teachers (Karabacak et al., 2015) and even assessors (Çevik, 2015).

3.2 Problem Solving Skills for Each Aspect

The average recapitulation of N-Gain scores of each problem-solving skill indicator is illustrated in the bar chart in Figure 1.



Annotation:
A: Useful Description
B: Physics Approach
C: Specific Application of Physics
D: Mathematical Procedures
E: Logical Progression

Figure 1: Chart of problem solving skill for each aspect.

Figure 1 shows that student problem-solving skills for each problem-solving skill indicator increase after SAS with PBL. The order of improvement of each problem-solving skill indicator from the largest is physics approach, a specific application of physics, mathematical procedures, logical progression, and useful description.

Useful Description. These aspect skills train students to reveal or redefine problems or problems in drawings or sketches that are easier to understand. If the problem is long and difficult can be simplified, further problem-

solving skill steps will be easier. This phase is similar to the translation phase of the TADIR model (Translation, Analysis, Design, Implementation, Review). The TADIR method is a thought line that may be related to how and where knowledge and skills are used in problem-solving (Barojas and Pérez, 2001).

PBL facilitates students to solve problems even though the problem is unstructured (Bigelow, 2004). The N-Gain value of this aspect is the smallest although in the medium category. This indicates that students are not used to translating a case in a simple sketch. Although the problem-solving skills here are physics issues, they can be miniaturized in how we deal with the problems of our lives. Many people are not able to solve the problem of his life because he is not able to simplify the problem. He was unable to see a simpler version or another model of the problem. Getting the ability of the useful description is the same as setting the ability to simplify the problem. This ability is needed by 21st century humans.

Physics Approach. The physics approach aspect has the highest increase compared to other aspects. This is possible because students are already used to using physics approaches to solve problems. This skill actually trains a person to take a view or an approach in solving a problem. The physics approach is used by us to solve problems related to basic concepts or laws of physics. For example, when our car broke down, physicists suspect that the cause may be due to exhaust gasoline or because there is mechanical damage etc. But deciding to pick the right and appropriate repair shop to fix the car would, of course, use another point of view. Studying students to get used to taking a single point of view in solving problems is indispensable today.

Specific Application of Physics. This ability brings students to be able to apply the concepts and principles of physics to the specific conditions of a problem. According to the physics view, there are times when we must use some approach or assumption so that the laws or principles of physics may apply, for example, neglected friction, mass pulleys, or mass of rope is negligible. Selection of this approach is taken to make problem-solving simpler. The improvement of the specific application of physics is second only to the physics approach aspect. This happens because students have found physics approaches in the second aspect, so they only put the chosen approach to the specific conditions that fit the problem. Skills of this type can also be used more widely in everyday life. There are times when we are faced with complicated and difficult problems. The election of a principled strategy is sometimes ineffective and difficult. However, if we want to make certain restrictions that do not alter the substance, the problem will be more easily resolved.

Mathematical Procedure. This aspect trains students' skills in using appropriate and correct mathematical rules and procedures to solve problems. The term mathematical procedure refers to techniques used to solve problems from certain physical equations, such as isolating and reducing the strategy of algebra, substitution, the use of quadratic formulas, or matrix operations. The term mathematical rules refer to mathematical conventions, such as the use of parentheses, square roots, and corresponding trigonometric identities. The aspect of mathematical procedure has increased (third category) third. In the point of view of the problem solving of physics, mathematics is a tool or knife to split and peel the problem so easily broken down and solved. Mathematics is both an art and a language of communication. To solve everyday problems, it sometimes requires appropriate language or art and that the problem is easy to understand and easy to solve.

Logical Progression. The latter aspect of the problem-solving skill assesses students' skills in communicating reasoning, staying focused on goals, and evaluating consistent solutions (implicitly or explicitly). This phase checks whether the overall problem solution is clear, focused, and logically organized. The logical term means that the solution is coherent, internally consistent (the part is not contradictory), and is consistent externally (in accordance with physics expectations). The N-Gain logical progression value of the student shows the number 0.68 (medium category). Previous studies show that daily problem solving can be predicted by cognitive styles mediated by logical thinking (Pezzuti et al., 2014).

4 CONCLUSIONS

The results of the analysis show that problem-based learning with modified student sheets can facilitate prospective science teachers in enhancing problem-solving skills which in turn will make them accountable for their learning and empowered to address real-life problems (Shadday, 1999). With a touch of other methods such as creative problem-solving model (Kashani et al., 2017) and the STEM approach (Liao et al., 2016) and continuous practice will, over time, shape the skills of the other skill are like creative thinking skills. Slowly but surely with the spirit of learning and self-development (Crick and Wilson, 2005) and the spirit of interdisciplinary collaboration that forms integrative learning (Beagle, 2012), 21st century skills will populate the world of education.

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