Research Article

Application of two problem solving cycles to students' higher-order thinking skills on reproductive system material

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INTRODUCTION

Globalization era is discovered by a competition between countries in various aspects of life including human resources (Jariyah, 2017). The quality of human resources not only will determine the progress of a country but also determine the competitiveness between nations. This condition demands an increase in the quality of human resources in the field of education. Education should be designed to be able to equip the students with challenges in the globalization era. To deal with these challenges, the students have to be able to learn independently and develop their reasoning and thinking abilities (Wahyuni et al., 2018). This is in line with the learning objectives from primary school to college, in which it is to establish intellectual people who are able to think and solve problems. In order to solve the problem on his/her own, each person is required to have the ability to think at a higher level.

Higher-order thinking skills are abilities that do not only require memory skills but also render a person to be able to carry out a series of cognitive activities such as the entry of new information, questioning the truth, and changes that may occur, managing information in various ways, points of view, and possibilities, and reviewing results as well. This series of activities are called as higher-order thinking skill (Fatimah et al., 2019).
According to Fayakun and Joko (2015), higher-order thinking skills encompass cognitive abilities in the realm of analyzing (C4), evaluating (C5), and creating (C6). Higher-order thinking skills make the students be able to differentiate ideas or notions clearly, able to solve problems, and argue well, able to hypothesize and comprehend complex matters to become clearer (Widodo & Kadarwati, 2013).

Sudewi and Tika (2014) assert that ideal learning to stimulate and practice higher-order thinking skills is by means of problem-based learning. This learning allows the students to express their ideas openly, and develop their thinking abilities. The advantages of problem-based learning are providing students with diverse learning experiences such as collaboration and interaction in groups, increasing students’ understanding of what they are learning, gaining learning experiences related to the skills of applying scientific methods in problem-solving, and fostering a critical mindset (Rahayuni, 2016). Thru problem-solving, the students can transfer knowledge and understand the physical situation around them. Problem-solving skill is an individual competence to discover the solution in various problems thru logical ways (Demirel et al., 2015; Dostál, 2015). Problem-solving learning can use two cycles so that the learning is more effective (Puspitawati et al., 2018). Problems allow students’ initial knowledge to be built to relate new information to an event (Sitti et al., 2013).

Two problem solving cycles is a problem-based learning in two learning cycles. The learning stages of problem-solving in each cycle consist of (1) identifying problems; (2) problem formulation; (3) designing & implementing the problem stages; (4) analyzing the results; and (5) concluding and reflecting as well. In this case, first cycle focuses on obtaining the human reproduction concept (this material is used due to the lack of student knowledge about the reproductive system). Then, it is followed by the second cycle to implement the concept of complex problems related to human reproductive system. Both of the cycles allow the students to implement their concept thru a scientific approach to solve the problems (Riantoni et al., 2017).

Learning method that usually applied by the teacher in class is lecture method. However, it should be when the learning process, the teachers need to stimulate the students’ higher-order thinking skills. Previous learning methods need to be improved in order to improve the students’ higher-order thinking skills by applying the appropriate model; thus, this study is important. According to Puspitawati et al. (2018), two problem solving cycles can improve the students’ thinking skills and it is effective to be used in the learning. Departing from the above background, this study is carried out to discover whether there are differences in learning two problem solving cycles on the students’ higher-order thinking skills or not. Problem-solving skill is very important to be possessed by the students. This skill can assist the students in dealing with rapid societal changes (Kurniati et al., 2016). Problem-solving skill is integrated in the learning activities, especially in the field of science and technology (Destalia et al., 2014). The results of this study can be used as a reference for further study of two problem solving cycles learning.

**METHOD**

This experimental study is carried out using non-equivalent control group design as elucidated in Table 1.

| Class               | Pretest | Treatment | Posttest |
|---------------------|---------|-----------|----------|
| Experiment 1        | O1      | X1        | O2       |
| Experiment 2        | O3      | X2        | O4       |

This study is conducted in SMA Negeri 02 Sekayam on the even semester of academic year of 2019/2020. Population used in this study is the whole students of 11th grade of Natural Science. The XI IPA 1 class is used as the experimental class 1 and the XI IPA 2 class is used as the experimental class 3 based on the homogeneity test of final exam results and it is stated that both of classes are homogenous; hence, sampling uses a saturation sampling technique. The experimental class 1 uses two problem solving cycles and the experimental class 2 uses problem-based learning. Numbers of students embroiled in this study are 60 students, in which the numbers can be seen in Table 2.

| Class                          | Male n (%) | Female n (%) | Total n |
|-------------------------------|------------|--------------|---------|
| 11th Grade of Natural Science 1 (XI IPA 1) | 9(30)      | 21(70)       | 30      |
| 11th Grade of Natural Science 2 (XI IPA 2) | 15(50)     | 15(50)       | 30      |

Learning stages of two problem solving cycles consist of identifying problems; problem formulation; designing and implementing problem-solving stages; analyzing the results; and concluding and reflecting. The
first cycle focuses on obtaining the concept of reproductive system in humans, followed by the second cycle to apply the concept of complex problem conditions related to human reproduction table as shown in Figure 1. Stages of problem-based learning are shown in Table 3.

Table 3. Operational syntax of problem-based learning

| Operational syntax of problem-based learning |
|---------------------------------------------|
| 1. A problem is provided to the students |
| 2. Students discuss a problem of PBL tutorial in a small group. The students clarify facts of a case or problem; then, the students define a problem |
| 3. Students are embroiled in an independent study to finalize a problem outside the teacher’s guidance |
| 4. Students share information about the problem |
| 5. Students provide a solution of the problem |
| 6. Students conduct a review about what they have learned during the operation process |

Test instrument is used as data collection tool. The test instrument is established based on the higher-order thinking skill indicators i.e. analyzing, evaluating, and creating (Alhaddad et al., 2015). The test instrument is composed of 12 essay questions. All of the items are declared valid and the test instrument is feasible to be used, the validation is carried out by two lecturers and a teacher. All of the items meet the criteria for the level of difficulty and different power parameters. After the data are obtained, data analysis is required by using SPSS 22.

RESULTS AND DISCUSSION

The data results of pretest and posttest of students for each class are used as basic analysis to identify whether there are differences in learning two problem solving cycles on the experimental class 1 and problem-based learning on the experimental class 2. The analysis results of pretest score indicate the mean score of experimental class 1 (38.23) and the experimental class 2 (35.97). Those results indicate that the initial skill of the two classes is still low, in which it is shown in Table 4. The normality and homogeneity tests show the data that normally distributed and homogenous. Then, T-test obtains the results of sig (2-tailed) 0.458 > 0.05, in which it indicates that the pretest score of experimental class 1 and experimental class 2 do not have a significant difference on the students' initial skills. Furthermore, the posttest score was tested to determine the final ability of higher-order thinking skills in the experimental class 1 and experimental class 2, it can be seen in Table 5.

The analysis results of posttest score indicate the mean score of experimental class 1 (51.43) and experimental class 2 (44.03). The normality test of posttest obtains the results of data that are not normally distributed as shown in Table 5. Based on the results of U Mann Whitney test in Table 6, it shows that the posttest score of experimental 1 and experimental class 2 have a significant difference on the final skill of higher-order thinking of students.

Table 4. Test results of pretest score

| Class       | Mean  | SD    | Normality test | Homogeneity test | T-test Sig (2-tailed) |
|-------------|-------|-------|----------------|------------------|----------------------|
| Experiment 1| 38.23 | 11.443| 0.051          | 0.853            | 0.458                |
| Experiment 2| 35.97 | 12.003| 0.112          |                   |                      |
The difference in the students’ high-order thinking skills between the experimental class 1 and the experimental class 2 is due to differences in the treatment given, where the experimental class 1 uses two problem solving cycles and the experimental class 2 uses problem-based learning. The implementation of two problem solving cycles of learning gives the same results in terms of analysis so that there are no other factors that influence the results obtained (Puspitawati et al., 2018). Higher-order thinking skill can make an individual to be able to interpret, analyze or even manipulate the information that has been obtained. Based on Fayakun and Joko (2015), higher order thinking skills encompass the cognitive ability i.e. analyzing (C4), evaluating (C5), and creating (C6). The students who have higher-order thinking skills are able to identify the main ideas, analyze the argumentation, and provide the use of known things to answer questions, so that it has fairly good analytical skills. The students are able to give assessment to the learning and solution used. The students are also able to design how to work and provide correct answers; thus, the students have fairly good creation ability (Kurniati et al., 2016). In this study, the students are given problems in the form of news clippings in each meeting cycle. According to Rofiah et al (2013), one of the ways to improve the students’ higher order thinking skills is by exposing the students to a problem they have never encountered before. This can continuously train the students’ higher-order thinking skills. Higher-order thinking can also be interpreted as thinking at a higher level, not just memorizing facts. Thru a learning of two problem solving cycles, it can improve the students’ higher order thinking skills and it is effectively used in learning (Puspitawati et al., 2018).

There are two cycles in problem-solving learning that are effective to achieve the results of problem-solving learning. In the implementation of two cycles, repetition can be carried out to practice the problem-solving skill and check out the concept (Destalia et al., 2014). Two problem solving cycles is a learning based on two cycles of meeting by using problem-based learning. The first cycle focuses in obtaining the concept of reproductive system in human, followed by the second cycle to implement the concept of complex problems related to the human’s reproductive system. The two cycles allow the students to implement their concept thru a scientific approach in order to solve the problems (Lestari, 2015; Riantoni et al., 2017). The learning that uses problem-solving will improve the students’ success and metacognition ability. (Safitri et al., 2018; Saptasari et al., 2019). The use of two problem solving cycles learning will improve the higher order thinking skills of students thru a learning process of problem-based learning so that the students are easier to comprehend the learning concept especially in the reproductive system material. This learning also can improve the cognitive process including conceptual understanding, problem-solving skills, and ability to problem-solving (Khoriyah & Husamah, 2018; Wulandari & Surjono, 2013). Two problem solving cycles for each topic can develop a critical thinking and problem-solving skill (Purcell et al., 2012). The increase in students’ higher-order thinking skills makes the students more independent and can achieve better learning achievement as well. Problem solving skills are important skills in science learning (IPA) (Kurniati et al., 2016; Ramdiah et al., 2019). Garvey (2015) postulate that problem-solving is very important for students and it can build up a new scientific knowledge. Batubara (2017) assumes that problem-solving method simplify the students in completing daily problems since to achieve the understanding, the students must do the thinking activities by planting the concept of taking problems.

The results of this study indicate that the learning of two problem solving cycles is better that the problem-based learning in the learning outcomes of higher-order thinking skills, it can also be understood that a lot of
studies are needed in the future. Problem based learning is one of the methods that mostly used and proven to improve the ability to discuss, ask questions, and think critically (Schmidt et al., 2011; OECD 2013). Additionally, it can improve the students’ thinking skill in various academic fields (Hambach et al., 2016; Li et al., 2011; Van Hayus et al., 2014). Problem-based learning is learning that has an essence in the form of presenting various authentic and meaningful problem situations to the students. The results of this study prove that two problem solving cycles have the same potential success as problem-based learning.

CONCLUSION

There is a significant difference in learning to the higher-order thinking skills by the application of two problem solving cycles learning than problem-based learning in reproductive system material, in which the value of the significant difference is 0.015.

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