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Enhancing Problem Solving Skills of Pre-Service Teachers by Integrating 21st Century Interdisciplinary Theme Into Science Class

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***Abstract*— Mastery of key academic subjects in school is not enough to succeed in the 21st century. Some specific skills, such as problem-solving, needed. On the other hand, it is also important to foster understanding of academic content at much higher level by relating 21st-century interdisciplinary theme, such as health literacy, into key subjects. Thus, higher education institutions must prepare their students, especially those who will be a teacher in the future, to succeed in work and life by accomplishing problem-solving skills while learning key academic subjects. This research aims to develop a student worksheet that can enhance problem solving skills of natural science pre-service teachers weaved by physical exercise to maintain body endurance. The key academic subject in this research is the Human Movement which talks about muscle in the view of biomechanics and muscle metabolism during movement. The research method is descriptive quantitative with one group pre-test and post-test design. The data collection involves giving a test to students before and after the student worksheet was provided in the movement of human class. The results showed that the student worksheet could enhance students' skills.**

Keywords—Problem-solving skills; 21st century interdisciplinary theme; the movement and its changes course

I. INTRODUCTION

It is not possible to predict what will happen in the future. For example, in many industries and countries, the most in-demand occupations or specialists did not exist ten or five years ago. It is also estimated that 65% of children entering primary school today will end up work in a field that do not exist yet [1]. Thus, the next generation must be prepared by some skills that they need most for their future live. Regarding to the summary of skills required in 2020, around 36% of all jobs across industries requires complex problem-solving skills [1]. Thus, the skills that most highly valued by companies and society is related to problem solving skills. As for content skills and cognitive abilities, those skills will be a growing part of the core skills [1].

There are four stages of problem solving skills, i.e. 1) understanding the problem, 2) planning the completion, 3) implementing problem-solving solution based on the plan, and 4) re-checking [2]. In order to master those skills, education is a key to succeed. Schools will prepare our next generation who can fulfill this demand. Teachers should integrate problem-solving skills in key subjects. It is also important to weave 21st century interdisciplinary themes into key subjects, such as global awareness, financial, economic, business and entrepreneurial literacy, civic literacy, health literacy, and environmental literacy [3]. Progress in cognitive science suggest that students acquire core subject best by emphasizing their learning depth over breadth of coverage [4]. Modern life also requires students to apply what they have learn on the job, in communities, and further studies [4].

Universitas Negeri Surabaya (UNESA) as one of a higher education institution in Indonesia has an important role to prepare teachers who capable to answer the demand of the 21st century live. The graduate of Unesa are expected to master the content of key subject and to have skills that is needed for 21st century live, such as problem-solving skills. One of those graduates are from the Natural Science Department which prepare student to become science teacher of secondary school in the future.

The Regulation of the Minister of Education and Culture of Indonesia No. 22 Year 2016 states that students of secondary levels learn science through integrated manner. As for natural science, integrated science means to explore phenomena in natural life in the view three disciplines which are biology, physics, and chemistry [5]. It is also written in the regulation that scientific method must be applied in learning process. This regulation is accordance with the meaning of learning science. Science describes as a systematic, organized, general, universal, and a collection of observed and experimental data about natural phenomena [6]. Thus, the pre-service teacher must be prepared to fulfill the expectation of education demand. In addition, it is needed to give them experiences to solve problem because it is also important for them in the future life.

Preparing a learning process for pre-service teacher with problem-based environment can enhance their problem-solving skills during the class. However, some plans are needed here. Making a worksheet is one of those plans. The worksheet contains not only with academic content, but also it must be based on actual problem that pre-service teachers need. In this

research, a worksheet prepared is a worksheet for Movement in Human course. This worksheet contains not only about human movement, which related to muscle contraction, biomechanics, and muscle metabolism, but also emphasized one of 21st century themes, which is health literacy. The worksheet talks about body endurance and guide pre-service teacher to find out the best way to measure their body endurance level and to keep body in a good state. This worksheet is called "Body Endurance Worksheet".

Therefore, the aim of this research is to find the effectiveness of Body Endurance Worksheet to increase the understanding of pre-service teachers' toward Human Movement course content while enhancing their ability to solve problems. The effectiveness is shown by pre-service teachers' achievement in problem-solving skills and academic content.

II. METHOD

The method of this research is descriptive quantitative with one group pre-test and post-test design as follows.

$$O1 \quad X \longrightarrow O2 \quad [7]$$

Information:

O1 = score of pre-test (before treatment)

O2 = score of post-test (after treatment)

X = treatment with the implementation of learning with the student worksheet to train problem-solving skills

Subjects of this research are 18 pre-service teachers of the Natural Science Department whose given test before and after treatment. The research instrument is a test sheet of The Human Movement course. The test determines problem-solving skills of pre-service teachers' including a) identifying and selecting the problem, b) formulating a hypothesis, determining variables, and designing the experiment, c) Implementing the solution: collecting data, analyzing, and d) making conclusion and evaluation the solution. The formulation to find out pre-service teachers' achievement is as follows.

$$\text{Percentage of Problem} - \text{solving skills} = \frac{\text{Pre-service teacher's score}}{\text{total score}} \times 100\% \qquad (1)$$

Students' achievement will be interpreted into criteria to determine the feasibility of student worksheet developed. The criteria for problem-solving achievement for pre-test and post-test are as follows. [8]

TABLE I. SCORE CRITERIA OF PROBLEM-SOLVING SKILLS

Score	Criteria	Description
0 – 20	Very low ability	The student cannot solve problem
21 – 40	Low ability	The student know how to state problems, yet the student cannot solve the problem.
41 – 60	Average ability	The student has an average ability to solve the problem.
61 – 80	High ability	Student can solve the problem, yet the student need some improvement in some problem-solving skills.
81 – 100	Very high ability	The student has a very high ability to solve the problem.

In order to analyzed the increase of problem-solving skills after treatment, students' score achievement will be measure using formula as follows.

$$< g > = \frac{\%<G>}{\%<G>_{max}} = \frac{(\%<S_f> - \%<S_i>)}{(100 - \%<S_i>)} \qquad (2)$$

Information:

<g> = normalizes gain score

S_f = post-test score

S_i = pre-test score

The criteria of score interpretation of problem-solving skills achievement are shown as follows.

Table II Criteria of Score on Problem Solving-Skills Achievement

TABLE II. SCORE CRITERIA OF PROBLEM-SOLVING SKILLS ACHIEVEMENT

Percentage (%)	Criteria
(<g>) > 0.7	High
0.7 > (<g>) > 0.3	Average
(<g>) < 0.3	Low

III. RESULTS AND DISCUSSION

During the period between pre-test and post-test, pre-service teachers learned in a small group to master academic content while solving problem guided by the student worksheet. The topic of the worksheet is human body endurance. First, the worksheet talks about how important for students to keep healthy by knowing their body endurance level even though they have many activities on campus. After that, the worksheet guides the students to find several ways in order to measure the body endurance level. Students must decide the best way and discuss their choice with the lecturer. If the lecturer approves their design, then they can implement it to measure their body endurance. The result of the measurement will be analyzed to find out more about their health. If the results are good, students must discuss how to maintain it. However, another possibility would be a lousy condition, and then students should discuss how to solve their body endurance problem. At the end of the worksheet, students relate the movement during the test of body endurance level with academic content, such as muscle movement in the view of biomechanics field and metabolism in muscle during the movement.

The data of problem solving results are advantageous through scoring the pre-test and post-test used to test which measures 100 minutes. Pre-test scores obtained from tests conducted before learning and post-test. The results for testing the performance of each indicator can be noted as follows.

TABLE III. THE RESULTS OF PRE-TEST AND POST-TEST FOR EACH INDICATORS OF PROBLEM-SOLVING SKILLS

No.	Indicator of Problem-Solving Skills	Pre-test	Post-test	Gain Score	Criteria
1	Identify and state the problems	25.28	86.39	0.82	High

No.	Indicator of Problem-Solving Skills	Pre-test	Post-test	Gain Score	Criteria
2	Formulating hypothesis and planning the experiment	25.83	81.67	0.75	High
3	Collecting the data	25.83	76.11	0.68	Average
4	Analyzing the data	26.39	79.72	0.72	High
5	Making conclusion and evaluating	20.28	74.44	0.68	Average

Based on Table III it can be seen that three indicators of problem solving skills increase reached high criteria, namely indicators "identifying and formulating problems", "formulating hypotheses", and "testing hypotheses". Meanwhile, two other indicators, namely "collecting data" and "drawing conclusions" are in average criteria. However, students improve their skills after the lesson.

Table IV shows the results of students' pre-test and post-test. Table IV also shows gain score analysis to determine the increase of individual score.

Based on Table IV, it is known that most of students' problem-solving skills are in the High category (13 students). Only five students are is average category. Meanwhile, based on the test scores (pretest and posttest) conducted, shows that the worksheet that have been made help students improve problem solving skills related to problems related to Human Movemant problem (Table III).

This skill enhancement is certainly done in stages through discussion among students and also between students and lecturer. The discussion expand student knowledge by sharing information within group.

TABLE IV. THE RESULTS OF PRE-TEST AND POST-TEST FOR EACH INDICATORS OF PROBLEM-SOLVING SKILLS

No.	Pretest	Posttest	Gain Score	Criteria
1	17	70	0.64	Average
2	21	74	0.67	Average
3	40	78	0.63	Average
4	23	80	0.74	High
5	25	85	0.80	High
6	21	79	0.73	High
7	17	82	0.78	High
8	13	83	0.80	High
9	17	76	0.71	High
10	15	83	0.80	High
11	45	89	0.80	High
12	41	75	0.58	Average
13	21	78	0.72	High
14	14	76	0.72	High
15	19	84	0.80	High
16	24	84	0.79	High
17	33	80	0.70	High
18	41	81	0.68	Average

IV. CONCLUSION

The conclusion of this study is that the worksheet can improve student ability to solve problem. However, pre-service teachers need more time and more experience for polishing the skills further. Problem-solving skills are not skills that can be master just in a short time. Therefore, other problem-solving worksheet are needed.

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