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Analysing problem solving skills of secondary school students by using a student worksheet

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Analysing problem solving skills of secondary school students by using a student worksheet

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Abstract. The study aimed to described problem solving skills of secondary school students using a student worksheet (SW). The design of study was pre-experimental by using quantitative descriptive approach. The parameters of the study were completion of the SW worksheet and students' activities. The findings showed that the students achieved in enough and good criteria for stages of problem solving. They gained an average score of 3.20 (good criteria) for identifying problems, 3.10 (good criteria) for designing solutions, 2.60 (good criteria) for collecting data, 2.30 (fair criteria) for determining solutions, 2.60 (good criteria) for reviewing solutions. For the students' activities, 56% of students' activities were categorized in very good criteria, then 36% of activities were categorized in good criteria and 8% of activities were categorized in enough criteria. The results of observing students' activities when using SW obtained a score of 3.38 with very good criteria. The results indicated that the students' problem solving skills and activities in using SW were achieved well. In other words, the students were skilled and active in terms of solving problem by using SW.

1. Introduction

21st century skills are interdisciplinary and relevant to many aspects of life but most focus on thinking skills, learning and communication skills. Students do not learn enough about basic knowledge, but also need to learn to think critically so that they are able to analyze and solve problems in an educated manner, can work with others, can communicate verbally and in writing effectively, thus they can share their opinions openly [1].

21st century learning plays a role in preparing human resources with the ability to ask questions, solve problems and think critically, conduct investigations and apply their findings [2]. Learning in the 21st century must focus on real world problems and processes, support an inquiry-based learning experience, provide opportunities for collaborative, and how students learn [3]. Rotterham and Daniel [4] stated that the best orientation of learning in the 21st century is students viewed a center of learning, for example Project Based Learning or Problem Based Learning that allows students to collaborate, work on original problems, and engage with the community.

Problem solving is the source of all new discoveries, social and cultural evolution, the basis for a market-based economy for continuous improvement, communication and learning [5]. Problem solving techniques will help students deal with problems in the school environment as well as in everyday life [6]. Problem solving is a strategic competence in the form of application of concepts and skills in understanding, choosing a solution strategy, and solving problems [7]. If the solution that is expected does not work as desired, the student must start thinking again from the beginning to get a

thorough understanding of the problem at hand [8]. The appropriate tool to train students' problem solving skills is students' worksheet (SW) [9].

Based on the explanation above, the study focused on the implementation of SW to train problem solving skills of the students evaluated using two parameters, that were, the students' achievements in terms of problem solving skills and the students' activities.

2. Research method

The type of study was pre-experimental study with purposive sampling technique [10]. The design of pre-experimental study was one shot case study. The study occurred in the even semester of 2017/2018 school year, May 4-7, 2018 at SMP (Junior High School) Negeri 21 Surabaya. The participants was year 8-H students. They were selected based on the ability of students who are homogeneous by considering the suggestion of the science teachers at the school.

3. Results and discussion

The problem solving skills in this study were evaluated using two aspects, that were, the results of the students' achievement in terms of problem solving skills and students' activities. The SW was used to train problem solving skills based on the problem solving stages proposed by John Dewey. A team of experts has validated the SW.

The SW began with a case study to orient students on the problem followed by the first stage of problem solving, namely identifying problems. At this stage students wrote down the main problems found and associate them with learning material through simple experiments or observations. The second problem solving stage was that the students were asked to design and write solutions that might be constructed based on theories. The third stage was collecting data. The students searched references about one of the dams in Indonesia in accordance with the instructions on the SW. The next step was to determine the solution. At this stage, the students were asked to write down the solutions based on their theoretical studies and references have been collected. The last stage of problem solving was reviewing. At this stage, the students were provided questions for helping the students to review each stage of problem solving process.

The students worked in groups and corresponding with instructions on the SW. Working on the WS aims to practice problem-solving skills and done in groups because it can make students learn to express their ideas, give and receive feedback that leads to a deeper understanding. In addition, group work encourages students to relate to one another, overcome feelings of isolation in large classes and encourage discussion in academic and other matters [11].

The SW was adopted from the development of problem solving based worksheets [9] and integrated with the problem solving stages according to John Dewey. The stages of problem solving included identifying problems, designing solutions, collecting data, determining solutions, and reviewing the problem solving process. At each stage, it has been equipped with instructions on the WS that facilitate the students in completing tasks.

Assessment of the results of working on the SW was based on the stages of problem solving carried out by each group. The score of each group was presented on Table 1.

Table 1. Assessment of the results of working on the SW.

No.	Problem Solving Stages	Group Score					Average	Criteria
		1	2	3	4	5		
1	Identifying problems	3.67	3.33	3.00	3.00	3.00	3.20	Good
2	Designing solutions	3.00	3.50	3.00	3.00	3.00	3.10	Good
3	Collecting data	2.00	3.00	4.00	2.00	2.00	2.60	Good
4	Determining solutions	2.00	2.00	3.50	2.00	2.00	2.30	Fair

No.	Problem Solving Stages	Group Score					Average	Criteria
		1	2	3	4	5		
5	Reviewing	2.00	2.00	3.00	2.50	3.50	2.60	Good
	Average	2.53	2.77	3.30	2.50	2.70		
	Criteria	Good	Good	Very good	Fair	Good		

Based on the Table 1, reviewed based on the achievement of each stage of problem solving, the stage of identifying problems have an average of 3.20 with good criteria, the stage of designing solutions gained a score of 3.10 in good criteria, the stage of collecting data achieved a score of 2.60 in good criteria, the stage of determining solutions were at the lowest score of 2.30 or fair, and the review stage got a score of 2.60 or in the good criteria.

When viewed from the group acquisition, Group 3 got the highest average score from all stages of solving with a score of 3.30 or very good, while the lowest score is obtained by Group 4 with a score of 2.50 with fair criteria. This was because at the stage of determining the solution was identical to the settlement at the stage of designing the solution, while according to Winarso [8], the skills needed at the stage of designing solutions and the stages of determining solutions are very different. At the stage of designing solutions students were asked to imagine alternative solutions to problems, while at the stage of determining solutions students were asked to examine the data and facts that have been collected and then draw conclusions as an alternative solution to the problem.

Observing students' activities consists of 4 aspects, namely contributing to achieve the goal, doing experiment, contributing ideas, working and sharing with others. This observation was carried out to determine the activities of students individually in groups during learning activities. The results of observations of students' activities for each aspect were presented in Table 2.

Table 2. Results of assessment of students' activities in groups.

Std.*	Observed Aspects				Avg.**	Criteria
	Contributing to achieve the goal	Doing experiment	Contributing ideas	Working and sharing with others		
1	4	4	3	4	3.75	Very good
2	4	4	4	4	4.00	Very good
3	2	3	2	3	2.50	Fair
4	4	4	4	4	4.00	Very good
5	3	3	2	3	2.75	Good
6	3	3	2	3	2.75	Good
7	4	3	3	3	3.25	Very good
8	3	3	3	2	2.75	Good
9	4	4	4	4	4.00	Very good
10	3	4	3	4	3.50	Very good
11	4	4	3	3	3.50	Very good
12	4	4	4	4	4.00	Very good
13	4	4	3	4	3.75	Very good
14	3	4	3	4	3.50	Very good
15	4	4	3	4	3.75	Very good
16	3	3	2	3	2.75	Good
17	4	4	4	4	4.00	Very good
18	3	3	3	3	3.00	Good
19	4	1	3	4	3.00	Good
20	3	2	3	2	2.50	Fair
21	4	4	4	4	4.00	Very good
22	3	4	3	4	3.50	Very good
23	3	3	3	3	3.00	Good
24	4	4	4	4	4.00	Very good

Std.*	Observed Aspects				Avg.**	Criteria
	Contributing to achieve the goal	Doing experiment	Contributing ideas	Working and sharing with others		
25	4	4	3	4	3.75	Very good
26	3	3	3	4	3.25	Good
27	3	3	6	3	3.00	Good
28	2	3	4	3	3.00	Good
29	4	4	4	4	4.00	Very good
30	3	3	3	3	3.00	Good
31	3	3	2	3	2.75	Good
32	2	2	6	3	2.50	Fair
33	4	4	4	3	3.75	Very good
34	4	4	4	4	4.00	Very good
35	4	3	3	3	3.25	Good
36	4	4	4	4	4.00	Very good
Avg.	3.44	3.42	3.19	3.47	3.38	Very good

*Std.: Student; **Avg.: Average

The recapitulation of the Table 2 showed that 56% of students have very good activities, 36% are in good categories, and the remaining 8% are in fair categories. The assessment of students' activities also aimed to assess the extent to which students contribute to the group. Quoting from Nugraheni [12] said that the more active students, the better their achievements. Based on the quote, the reason why the students were in fair category was that they were less active during the learning activities. Percentage of the number of students on each level of students' activities criteria was pictured in Figure 1.

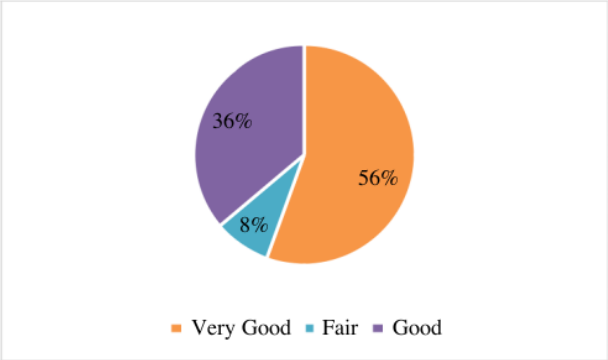

Fig 1. Percentage of the number of students on each level of students' activities criteria

Students' problem solving skills were based on the results of the worksheet and the students' activities presented in Table 3.

Tabel 3. Average score of students' problem solving skills

No.	Assessment indicators	Assessment aspects	Average score	Criteria
1.	Student's Worksheet	Identifying problems	3.20	Good
		Designing solutions	3.10	Good
		Collecting data	2.60	Good
		Determining solutions	2.30	Fair

No.	Assessment indicators	Assessment aspects	Average score	Criteria
2.	Students' Activities	Reviewing	2.60	Good
		Contributing to achieve the goal	3.44	Very Good
		Doing experiment	3.42	Very Good
		Contributing ideas	3.19	Good
		Working and sharing with others	3.47	Very Good
		Average	3.04	Good

The results of statistical analysis showed that the average score of students' problem solving skills was 3.04 in good criteria. These results indicated that using the SW can force the students' problem solving skills and students' activities..

4. Conclusion

Based on the results of the analysis and discussion can be summarized as follows:

1. Students' problem solving skills using the SW achieved a score of 3.20 for identifying problems, 3.10 for designing solutions, 2.60 for collecting data, 2.30 for determining solution, and 2.60 for reviewing with category of good, good, good, fair, and good respectively.
2. Students' activities when using worksheets that apply problem solving skills got an average of 3.38 in very good category.

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