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Problem solving skills improvement and the impact on students' learning outcomes: learning based e-project

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Abstract: Problem solving skills have important role on process science skills. These skills are part of 21st century priority skills in Indonesia. This study aims to analyze the impact of learning based e-project on problem solving skills. This study employed methods a nonequivalent control group design. The subject of this research are students' of class XI MIPA 1 as class of experiment 1 and XI MIPA 2 as class of experiment 2 of SMA Yadika 9 Bintara, Bekasi, West Java with purposive sampling technique. Experiment class received treatment used e-project based learning. Experiment classes are giving the e-project to improve problem solving skills and control classes are learned conventionally. Data was collected through pretest and posttest results from students' in both classes. A t-test was used and it is found that level of significance is 0.006 (sig. < 0.05) proving that e-project based learning is effective to improve students' problem solving skills.

1. Introduction

Education has an essential function to improve human source. Education is functioned as utility, facility, and guidance that could lead and developed education participant to be better for himself and community [9]. For that reason the purpose of education shall be set up, and is given orientation and appropriate guidelines, so that formulation of such education can be implemented in order to achieve its function very well [30].

Science learning essentially includes some aspects: factual the balance between the process and the product, actively took part in the investigation, think inductively and deductively, and development of behavior [4]. Science is human effort to understand the universe through observation that is right on target, as well as using procedure and explained logically to get conclusion [27]. Science is part of knowledge about nature that was result observation, thought, rationalizing, and a brilliant insight, but now, science not only part of knowledge, but also is a process of discovery or scientific method [12]; [13].

Learning based on project is one of the learning models who is accommodate the learning process to discovery and scientific method [6]. Learning based on project is an interactive learning model based on projects that can be used in chemistry material. Giving assignments in the form of projects can improve student learning outcomes on acid base materials [18]. Projects given to students are effective to improve student's thinking skills [3]. Learning based on project can improve student's critical thinking ability and self discipline [15], literacy skill and creative thinking [26], students Science, Technology, Engineering, & Mathematic (STEM) literacy [28].

In addition to the cognitive field, the implementation of project based learning can improve students' abilities in the fields of affective and psychomotor skills. Generally, students with the improvement psychomotor skills have a good learning outcome [25]. Affective skills with Islamic value can improve environmental literacy students based on project [11]. Therefore, implementation project based learning can improve the students' scientific literacy [2], activities [14]; [21], equip foundational knowledge [17], and also cognition, motivation, and attribution [16].

Problem solving is a skill who related to mathematical knowledge, general intelligence, general creativity, and verbal abilities [5]. Problem solving is related with conceptual understanding and procedural knowledge [22]. Problem solving can improve critical thinking ability [29], and development learning strategies [1]. It is necessary to improve the problem solving ability of student by increasing cognitive ability, and improve the quality of teaching [20].

Therefore, problem solving skills need to be developed so that students' thinking processes can be formed properly [29]. Problem solving skill can improve by used a case study [7], implemented of project management (identify, define, examine, act, and look) [19], facilities the students for publication [24], and making it count strategies [31].

Thus, improvement of problem solving skills must be possessed by students in order to be able to contribute to society in solving problems in real life communities [10], spontaneous and mood states [23].

Problem solving are important skills that must have by students, so they contribute positively in the classroom. With these skills, learning is more useful, more quality and brings students closer to real life. These skills are not self-formed, stimulus efforts are needed through the implementation of learning models such as project based learning as well as by cultivating other skills. These skills are important to improve students' learning outcomes.

2. Methods

2.1. Time and Place of Research
This research took place on SMA Yadika 9 Bintara, Jawa Barat. Research is being held on first semester of academic year in 2018/2019.

2.2. Type of Research
This research used quasi experimental design with nonequivalent control group design. This research consist two classes both are experiment and control class with purposive sampling technique. In experiment class, student's was taught used e-project based learning and control class student's learned conventionally.

2.3. Research Subject and Object
Subjects of this research are students of class XI MIPA 1 as experiment class and XI MIPA 2 as control class. Each class consisted of 30 students. The object of this research was given e-project about thermo-chemical. Object was purposed to improve students' problem solving skills and the impact to students' learning outcomes.

2.4. Techniques and Instruments of Data Collection
Data is collected in some steps, (1) giving pretest to both of experiment subjects, (2) giving e-project based learning to experiment class and paper to control class, (3) giving posttest to both of experiment subjects. Data collection format is served in Table 1.

Table 1. Experiment Design

Subject	Pretest	Treatment	Posttest
EC	X_1	P	X_2
CC	Y_1	Q	Y_2

Note:

EC : Experiment class
CC : Control class
X_1 : Experiment class starting skill
X_2 : Experiment class final skill
Y_1 : Control class starting skill
Y_2 : Control class final skill
P : The use of e-project based learning
Q : The use of conventional learning

Learning process is being held in 3 sessions for 8 meeting hours. First meeting in 3 hours discuss about thermo-chemical. Second meeting in 3 hours discuss about some subjects that can be transformed by the process. Third meeting in 2 hours discuss about e-project.

Data collection instrument is based on problem solving skills indicators [8] as shown on table 2.

Table 2. Problem Solving Skill Indicators

Problem solving aspect	Indicators
Transforming ability	a. Ability to read and comprehend
	b. Ability to read and observe
	c. Ability to connect to concepts of technical terms
	d. Ability to answer professionally
	e. Ability to answer logically
	f. Ability to analyze professional presentation
	g. Ability to express with symbol
	h. Ability to connect to symbol
	i. Ability to decode and concept to concept
Answering ability	a. Ability to connect to graphs
	b. Ability to connect to figures
	c. Ability to apply logical thinking
	d. Ability to apply conceptual connection
	e. Ability to determine the operations with symbols
	f. Ability to determine with professional knowledge
Interpreting ability	a. Ability to interpret the professional presentation
	b. Ability to recount the result
	c. Ability to decode the result of the formulation
	d. Ability to explain the result
	e. Ability to conclude logically
	f. Ability to interpret
Verifying ability	a. Ability to decode for calculation
	b. Ability to design professionally
	c. Ability to review applications

According to problem solving skills indicators, experiment data can be collected though problem solving skills and learning outcomes test. Problem solving skills test consists of 20 multiple choice question and 5 essays. Students' learning outcomes test consists 25 multiple choice and 5 essays. Data of students' problem solving skills results is gained from pretest as starting skill and posttest as final skill.

2.5. Data Analysis Technique
Data research analyzed based on the gain score, normality test, homogeneity test, and t-test using SPSS 21. Gain score is used to see the difference between posttest and pretest score. The value of the score is used in order to understand the increase in problem solving skills students after going through treatment. Gain score of problem solving results can be calculated by using this formula:

$$gainscore = \frac{score_{postest} - score_{pretest}}{score_{maksimal} - score_{pretest}} \tag{1}$$

Value of gain score can be categorized as shown in Table 3.

Table 3. Conversion of N-gain Into Category

Scale	Category
0.01 – 0.29	Low
0.30 – 0.69	Medium
0.70 – 1.00	High

Test of normality is used to see if problem solving skills data is distributed normally or not. Data that is used in normality test is gained from pretest. Result of normality test can be concluded as distributed by "Kolmogorov-Smirnov" if sig. > 0.05.

Test of homogeneity is used to see similarity of variants in experiment and control class. Data that is used in homogeneity test are gained from pretest. Result of homogeneity test is based on "Levene Statistic" if sig. < 0.05 then variant can be concluded as is unequal and if sig. > 0.05 then variant can be concluded as equal.

The test of hypotheses in the study is done by using independent t-test. Independent t-test is used to know the difference of the average generic skill between experiment class and control class. The base of decisions making in the independent effort whatever survives this test could be done based on value of sig. (2-tailed). If value sig. (2-tailed) > 0.05 then H_0 will received and H_a will rejected but if value sig. (2-tailed) < 0.05 then H_0 rejected and H_a were accepted.

H_0 : e-project based learning not effective to improve the students' problem solving skills

H_a : e-project based learning is effective to improve the students' problem solving skills

3. Result and Discussion

This research was being held on SMA Yadika 9 Bintara, Bekasi, Jawa Barat, Indonesia. This research consists of two classes both are experiment class and control class. In experiment class, student's was taught used e-project based learning to problem solving skill. In control class, students learned conventionally.

Research is begun with pretest and then continued in 3 sessions for 8 meeting hours. First meeting in 3 hours discuss about thermo-chemical. Second meeting in 3 hours discuss about some subjects that can be transformed by the process. Third meeting in 2 hours discuss about e-project.

All session are purposed to give treatment to control and experiment class. Posttest is purposed to determine final problem solving skills of students after getting treatment. Average posttest and pretest result are show in Table 4.

Table 4. Average Score of Posttest and Pretest

No	Class	Pretest	Posttest
1	Control	35.22	54.68
2	Experiment	34.86	72.88

According to the table, after getting treatment, control and experiment class showing improvement in problem solving skill. But, average improvement (pretest and posttest average score) of experiment class is higher than control class. So it can be concluded that students' problem solving skills improvement in experiment class is higher than control class. It shows that learning by used e-project based learning is more effective than conventional learning.

Problem solving skills improvement analysis can be seen and categorized based on gain score as shown on Table 5.

Table 5. Average Gains Score

No	Class	Gain	Category
1	Control	0.4879	Medium
2	Experiment	0.8665	High

Gain score analysis in this research shows that gain score of experiment class is higher than gain score of control class. According to table 5 can be categorized that students' problem solving skills improvement in control class are low but in the other hand are high in experiment class.

Hypothesis testing on this research is using independent t-test. Condition of parametric statistic testing on independent t-test had been through normality and homogeneity. Result of normality test is show in Table 6 and homogeneity test is show in Table 7.

Table 6. Test of Normality

| | Class | Kolmogorov-Smirnov[a] | | |
		Statistic	Df	Sig.
Pretest	Control	.085	30	.089*
Score	Experiment	.104	30	.089*

*. This is a lower bound of the true significance

a. Lilliefors significance correction

Normality test is being held to determine if problem solving skills data on control and experiment class are distributed normally or not. Result of normality test on table 6 shows that significance (sig.) of control and experiment class are higher than 0.05 (0.089 > 0.05). It can be concluded that data of control and experiment class are distributed normally.

Table 7. Test of Homogeneity of Variances

	Levene Statistic	df1	df2	sig.
Pretest Score	1.967	1	58	.083

Homogeneity test is being held to see if problem solving skills of control and experiment class variance based on Levene Statistic are homogenous or not. According to homogeneity test in table 7 showed that significance (sig.) are higher than 0.05 (0.083 > 0.05). It shows that control and experiment class distribution are homogenous.

According to normality and homogeneity test results, it shows that data is distributed normally and homogenous. Data that distributed normally and homogenous can be tested using independent t-test. Independent t-test is served in Table 8.

Table 8. Independent Samples t-test

	T	Df	Mean Difference	sig. (2-tailed)
Equal variances Assumed	10.158	58	23.34782	.006
Equal variances not assumed	10.158	58	23.34782	.006

According to the table, independent t-test result can be used to decide whether H_0 will be accepted or rejected. Value of sig. (2-tailed) of independent t-test is 0.006. It shows that value of sig. (2-tailed) $0.006 < 0.05$, so H_0 is rejected and H_a accepted.

In learning by giving projects, students are given the freedom to create and imagine the projects that have been made or will be made. Projects that have been done can stimulate them to introspect themselves according to the theory. The impact of self-introspection is apparently able to stimulate students to make other projects that are more appropriate in solving a problem. With the availability of many projects, students have a lot of options to be used as a solution to solve problems. With these options, it will stimulate the formation of problem solving skills in students [7]; [19]; [24].

4. Conclusion

Based on data analysis results and discussion can be concluded that learning used e-project based learning about thermo-chemical is effective to improve students' problem solving skills. This result is based on experimental class average score gain is better than control class average score with high category. Learning used e-project can make consisted of communicating in both writing and oral, planning the experiment, predicting hypothesis, interpreting the observation, observing, measuring, and using tools and material. Besides that, learning used e-project is easier to remember and it can improve students' problem solving skills and learning outcomes about thermo-chemical.

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