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¹Using Performance Assessment Model in Physics Laboratory to Increase Students' Critical Thinking Disposition

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Abstract: Performance Assessment Model (PAM) has been developed to represent the physics concepts which able to be divided into five experiments: 1) acceleration due to gravity; 2) Hooke's law; 3) simple harmonic motion; 4) work-energy concepts; and 5) the law of momentum conservation. The aim of this study was to determine the contribution of PAM in physics laboratory to increase students' Critical Thinking Disposition (CTD) at senior high school. Subject of the study were 11th grade consist 32 students of a senior high school in Lubuk Sikaping, West Sumatera. The research used one group pretest-posttest design. Data was collected through essay test and questionnaire about CTD. Data was analyzed using quantitative way with N-gain value. This study concluded that performance assessment model effectively increases the N-gain at medium category. It means students' critical thinking disposition significant increase after implementation of performance assessment model in physics laboratory.

1. Introduction

While a great deal of research has examined students' critical thinking skills, less is known about students' tendencies to use these skills [1]. Critical thinking has always been a central goal of education, but having critical thinking skills does not necessary meant that the person will use these skills even when the situation requires the application of such skills [2]. Critical thinking disposition is also believed to be essential for students, primarily to ensure they use critical thinking skills in the classroom and later when they enter the workforce, because people must also be disposed to use what they have learned [3, 4]. Some researchers extend the definition of critical thinking include both abilities and dispositions [5, 6]. Critical thinking dispositions define as the tendencies to think critically when faced with problems to solve, ideas to evaluate, or decisions to make [7, 8].

Educators need to measure critical thinking dispositions, it will help to decide on the appropriate intervention to implement. There are instruments to measure critical thinking dispositions such as: 1) California Critical Thinking Disposition Inventory/CCTDI by Facione; 2) Critical Thinking Disposition



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Questionnaire/CTDQ by Ricketts; and 3) Critical Thinking Disposition Scale/CTDS by Akbiyik. On the other hand, pre-service physics teachers' critical thinking disposition can improved through virtual lab modern physics model [9]. Based on the results of analysis journals, there is no instrument used to measure the critical thinking disposition in physics subject at the senior high school level. Field study shows the assessment used in senior high school is more oriented towards the end result, not the process. The facts reflected in local and national assessments using traditional assessment tools such as paper and pencil test that have not been able to measure students' higher order thinking. Assessment expert Lorrie Shepard and others have found that, when educators teach directly to the content and format of specific high-stakes tests, students are frequently unable to transfer their knowledge to items that test it in different ways [10]. Furthermore, students' ability to answer multiple-choice questions does not mean they have the ability to answer the same questions in open-ended form. Indeed, their scores often drop precipitously when answers are not provided for them, and they do not have the option to guess. Thus, a focus on multiple-choice testing gives false assurances about what students know and are able to do [11]. This is why a growing number of educators and policymakers have argued that new assessments are needed.

The increase in popularity of performance assessments during the late 1980s and 1990s came about in part because of dissatisfaction with traditional, multiple-choice tests [12]. In a performance assessment, rather than choosing among pre-determined options, students must construct an answer, produce a product, or perform an activity. Performance assessment encompasses a very wide range of activities, from completing a sentence with a few words (short-answer), to writing a thorough analysis (essay), to conducting and analyzing a laboratory investigation (hands-on) [13]. Because they allow students to construct or perform an original response rather than just recognizing a potentially right answer out of a list provided, performance assessments can measure students' cognitive thinking and reasoning skills and their ability to apply knowledge to solve realistic, meaningful problems. Literature survey on the assessment of critical thinking dispositions and habits of mind indicates that critical thinking dispositions has been assessed using approaches such as direct observation, rating scores, essays [14, 15]. Some of these methods are used in combination. Therefore, this study was planned to determine the contribution of performance assessment model in Physics Laboratory to increase students' Critical Thinking Disposition (CTD) at senior high school.

2. Experimental Method

This study was conducted on a senior high school in Lubuk Sikaping, West Sumatera, during first semester of 2016-2017 academic years. Participants of the study were 11th grade consist of 32 students. Sampling was carried out by purposive sampling. The research used one group pretest-posttest design.

The instrument in this study was developed from seven subscales of CTD by Facione [15]. Data was collected through essay test and questionnaire as a part of PAM. Each instrument in this study was integrated physics practicum material. PAM has been developed to represent the physics concepts which able to be divided into five experiments: 1) acceleration due to gravity; 2) Hooke's law; 3) simple harmonic motion; 4) work-energy concepts; 5) the law of momentum conservation. CTD essay test and rubric consists of 18 item. Subscale of CTD essay test are inquisitiveness (3 items), open-mindedness (3 items), systematicity (3 items), truth-seeking (3 items), analyticity (2 items), self-confidence (2 items), maturity (2 items). The reliability of CTD essay test is 0.802. CTD questionnaire consists of 50 item Likert type response. Subscale of CTD questionnaire are inquisitiveness (9 items), open-mindedness (8 items), systematicity (7 items), truth-seeking (9 items), analyticity (6 items), self-confidence (6 items), maturity (5 items). The reliability of CTD questionnaire is 0.836. Data was analyze using quantitative way with N-gain value. In this study only used one class by comparing the N-gain value between pretest and posttest.

3. Result and Discussion

3.1. Pretest, posttest and n-gain analysis of CTD essay test

Mean score pretest, posttest, and gain of essay test were analyzed descriptively. There is an increase in students' critical thinking disposition score from 56.59 to 84.11. Based on the calculation of the mean value $\langle g \rangle$ is 0.63 which is categorized as medium [16].

Table 1. Mean scores of essay test for each subscales of the critical thinking disposition

Subscales	Pretest	Posttest	N-gain (%)
Inquisitiveness	46.87	74.47	53.23
Open-mindedness	55.20	85.41	65.10
Systematicity	61.97	88.02	66.40
Truth-seeking	65.10	86.45	66.14
Analyticity	48.43	88.28	77.60
Self-confident	64.84	87.50	56.77
Maturity	52.34	79.68	44.79

Table 2. Normally on pretest and posttest score of essay

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest	0.109	32	.200*	0.967	32	0.422
posttest	0.104	32	.200*	0.976	32	0.681

Table 3. Independent sample test of essay

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1.538	.220	-14.01	62	.000	-27.5	1.96	-31.44	-23.59
pretest_posttest				57					
Equal variances not assumed			-14.1	958	.000	-27.5	1.96	-31.44	-23.59

Table 1 shows students' pretest, posttest, and gain score of essay test for each subscale of critical thinking disposition. As seen from Table 1, all the critical thinking disposition indicators have increased, marked a positive value on each % N-gain. The highest pretest main score was found on the truth-seeking indicator (65.1) and the lowest on the inquisitiveness indicator (46.87). The highest mean posttest was

1 found on the analyticity indicator (88.28) and the lowest on the inquisiveness indicator (74.48). The largest % <g> is obtained on the analytical indicator (77.6) and the lowest on the maturity indicator (44.79).

Kolmogorov-Smirnov and Shapiro-Wilk test on whether the data is distributed normally or not were applied. As seen from Table 2, the score distribution of essay pretest dan posttest displays a normal distribution (sig.>0.05). The result one-way analysis of variance on the significance difference between pretest and posttest essay test mean score are given in Table 3. The equality of the variances was checked through Levene F test and variance were found out to be homogeneous (sig.>0.05). As seen from Table 3, the different between mean score of pretest and posttest is significant (sig.(2-tailed)<0.05).

3.2. Pretest, posttest and n-gain analysis of CTD questionnaire

Mean score students' pretest, posttest, and gain of questionnaire were analyzed descriptively. There is an increase in students' critical thinking disposition score from 76.82 to 84.8. Based on the calculation of the mean value <g> is 0.316 which is categorized as medium.

Table 4 shows students' pretest, posttest, and gain score of questionnaire for each subscale of critical thinking disposition. As seen from Table 4, all the critical thinking disposition indicators have increased, marked a positive value on each % N-gain. The highest pretest main score was found on the maturity indicator (77.03) and the lowest on the open-mindedness indicator (67.48). The highest mean posttest was found on the maturity indicator (92.66) and the lowest on the analiticity indicator (77.60). The highest % <g> is obtained on the maturity indicator (64.60) and the lowest on the analiticity indicator (25.53).

Table 4. Mean scores of questionnaire for each subscales of the critical thinking disposition

Subscales	Pretest	Posttest	N-gain (%)
Inquisitiveness	76.82	84.81	31.61
Open-mindedness	67.48	80.57	36.52
Truth-seeking	72.40	80.47	25.62
Systematicity	75.11	85.04	36.55
Analyticity	68.23	77.60	25.53
Self-confident	72.66	83.20	32.52
Maturity	77.03	92.66	64.60

Table 5. Normally on pretest and posttest score of questionnaire

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest	0,128	32	.200*	0.967	32	0.422
posttest	0,131	32	.200*	0.976	32	0.681

As seen from Table 5, the score distribution of questionnaire pretest dan posttest displays a normal distribution (sig.>0.05). The result one-way analysis of variance on the significance difference between pretest and posttest questionnaire mean score are given in Table 6. The equality of the variances was checked through Levene F test and variance were found out to be homogeneous (sig.>0.05). As seen from Table 6, the different between mean score of pretest and posttest is significant (sig.(2-tailed)<0.05).

Table 6. Independent sample test of questionnaire

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper	
Equal variances assumed	0.957	0.33	-8.959	62	.000	-20.1	2.24	-24.61	-15.63
pretest posttest Equal variances not assumed			-8.959	60.9	.000	-20.1	2.24	-24.61	-15.63

4. Conclusion

Performance assessment refers to variety of task and situations in which students are given opportunities to demonstrate their understanding and to thoughtfully apply knowledge, skill, and habits of mind in a variety of contexts [13]. One reason that performance assessments embedded in classroom instruction may help support stronger learning for students is that they ensure that students are undertaking intellectually challenging tasks [12]. In this study, we can conclude that implementation a performance assessment model in physics subject effectively increases students' critical thinking disposition. It means students' critical thinking disposition increases because of variety and challenging task of performance assessment.

In the literature, we didn't encounter a study about assessment performance model effect upon individual's critical thinking disposition. But in experimental studies, it can be seen that individuals' critical thinking disposition increased with different application [17-20]. This research is limited to physics subject in senior high school level. Similar studies should be conducted in different subject such as biology and chemistry, and different workgroup.

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