DEVELOPMENT OF STUDENTS' WORKSHEETS BASED ON GUIDED INQUIRY MODELS TO TRAIN SCIENCE PROCESS SKILLS AND CRITICAL THINKING SKILLS IN PROJECTILE MOTION

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ABSTRACT

In facing AEC (ASEAN Economic Community) which has impacted education, the young generation of a nation must have higher-order thinking skills. One of the ways to achieve that purpose is through practicing science process and critical thinking skills since they start education early. To exercise those skills in our students, we need to develop supporting learning materials. In this study, we develop learning materials on the topics of projectile motion based on Guided Inquiry Model through developmental research within ADDIE. The learning materials are validated by two validators before tested to 19 students of X MIPA 2 at St. Hendrikus Senior High School. The results of the validation process indicate that the developed lesson plan is, the developed student's worksheet, and evaluation/assessment plan are very valid with score of 3.76, 3.67, and 3.61 (out of 4) , respectively. The field test indicates that the lesson plan is implemented quite well. According to the pre- and post-test results, students' critical thinking skills improve, which is indicated by average N-gain score of 0.39. Descriptively it also can be observed that the students' science process skills develop throughout the implementation process. Besides, according to the questioner answers, students give positive responses to the learning materials and their implementation. In conclusion, the evaluation shows that the students achieve good critical thinking and science process skills. The developed learning materials support learning activities which involve practicing in critical thinking skills and science process skills.

Keywords: *learning materials, critical thinking, science process skills, projectile motion.*

INTRODUCTION

Since the end of 2015, the era of the Asean Economic Community (AEC) has begun, which has had many impacts in various fields, one of which is education. In dealing with the MEA, it requires human resources who have the ability to think at a high level so that they are able to compete with other countries in ASEAN. The ability to think critically is one component of higher order thinking skills (Heong, et al., 2011, p. 121). Students are required to be able to recognize the problem at hand, understand the possibilities that occur, and be able to solve problems and find solutions to those problems. It has been mentioned above that critical thinking ability is one component of higher order thinking skills.

According to Scriven and Paul (1987) critical thinking is an intellectual process and a conceptual process, application, analysis, synthesis, and evaluating information obtained during the process of gathering information by various means of gathering that are useful for determining conclusions. The ability to think critically is compatible with physics. Physics studies about the symptoms that occur in nature. In physics, apply the scientific method. The scientific method is needed by students in understanding a phenomenon starting from formulating a

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problem, making a hypothesis, collecting data, analyzing data to drawing conclusions. So in learning physics it is necessary to practice science process skills. Science process skills are the processes by which students ask questions, hypothesize, communicate the data obtained, and gather supporting information to solve the problems faced (Nopitasari, Indrowati, & Santosa, 2012).

Critical thinking skills and science process skills can be trained more easily and well to students by utilizing learning tools. A learning tool that is suitable for training science process skills that can simultaneously train critical thinking skills is the Student Worksheet (LKPD). Learners worksheets are sheets containing assignments with instructions and steps to work on assignments, the assignments contained in the worksheets of students are not only questions but also practical activities that are in accordance with certain subjects and aim to fulfill KI and KD which applies according to the curriculum (Daryanto & Dwicahyano, 2014, p. 175).

Students' worksheet is usually arranged specifically for one of the topics. Parabolic motion is one of the complex subjects because parabolic motion is a combination of Regular Straight Motion (GLB) and Irregularly Changed Straight Motion (GLBB). Learning models suitable for practicing critical thinking skills and science process skills are guided inquiry learning models. Guided inquiry learning is learning based on inquiry process by providing assistance and guidance to students in the process of gathering information and completing assignments that will be reduced gradually in accordance with the development of student experience (Nurdyansyah & Fariyatul, 2016, p. 41). The guided inquiry learning model makes students active in solving problems and finding concepts independently through the process of formulating problems to conclude with the help of the teacher in the learning process. Based on the description above, the researcher has conducted research under the title Development of Student Guidance Worksheets (LKPD) Guided Inquiry Model for Practicing Science Process Skills (KPS) and Critical Thinking Ability (CBC) at the Subject of Parabolic Motion Discussion.

RESEARCH METHOD

This research is a type of research development with the Research & Development (R&D) research method and the research model that is ADDIE (Analysis-Design-Development-Implement-Evaluate). In the analysis phase it examines Critical Thinking Ability and Science Process Skills that students have and also examines the 2013 curriculum applied in learning. At the design stage the researcher designs the student worksheet which will be validated by two experts at the develop stage. Furthermore, at the stage of implementing student worksheet that was compiled, it was tested on 1 student of Class X Science 2 of Saint Hendrikus Senior High School Surabaya.

The results of the validation by the two validators will be processed and get an average that is converted according to table 1.

Table 1. Five-scale assessment category

Formula	Category
$\bar{x} > \overline{x_1} + 1{,}8\,S$	Very Good
$\overline{x_1} + 0{,}6\,S \quad < \bar{x} \leq \overline{x_1} + 1{,}8\,S$	Good
$\overline{x_1} - 0{,}6\,S \quad < \bar{x} \leq \overline{x_1} + 0{,}6\,S$	Pretty Good
$\overline{x_1} - 1{,}8\,S \quad < \bar{x} \leq \overline{x_1} - 0{,}6\,S$	Not Good
$\bar{x} < \overline{x_1} - 1{,}8\,S$	Very Bad

(Adapted from Widoyoko, 2016)

Keterangan:

$\overline{x_1}$ (average) = ½ (maximum score + minimum score)

S (standard deviation) = 1/6 (maximum score – minimum score)

The field test research design used was one group pre-test post-test design. This design is done to measure students' critical thinking skills. Pre-test is done at the beginning of learning before students get treatment. Then learning with the help of student worksheet is done and then tested again in the post-test. The results obtained are processed using Normalize Gain Score and converted according to table 2.

$$\text{N-}Gain = \frac{Sp \quad - Sp}{S_m \quad - Sp}$$

Keterangan:

Spre = score *pre-test* of student

Spost = score *post-test* of student

Smax = maximum score of student

Table 2. N-*Gain* category

Interval N-*Gain*	Category
0,70 < N-*Gain*	High
0,3 < N-*Gain* ≤ 0,70	Medium
N-*Gain* < 0,3	Low

(Adapted from Hake, 1998, page. 65)

In addition, students' critical thinking skills are also statistically analyzed by the normality test which results are interpreted according to table 3.

Table 3. Normality test criteria

Criteria	Explanation
Sig < α	Data Not Normal Distribution
Sig ≥ α	Data Normal Distribution

(Muhson, 2012)

After that the hypothesis test is done using parametric statistics, namely the two-paired t test if it is normally distributed and when using non-parametric statistics that is Wilcoxon test if it is not normally distributed. The results of the paired t-test obtained were interpreted according to table 4. and table 5.

Table 4. Criteria Criteria for Sig 2 Tailed in Two-Paired t Test

Criteria	Explanation
Sig 2 tailed < α	There is a difference between pre-test and post-test scores
Sig 2 tailed ≥ α	There was no difference between pre-test and post-test scores

Table 5. Criteria for the Value of t in the Two-Paired t Test

Criteria	Explanation
t is negative (-)	*post-test* is higher than *pre-test*
t is positive (+)	*post-test* lower than *pre-test*

(Muhson, 2012)

In learning also measure students' science process skills. The science process skills of students are measured through observations and work outcomes of LKPD. The results obtained are analyzed graphically and statistically, using a normality test which interprets the results according to table 3. After that the hypothesis test is done using parametric statistics namely one way anova test if normally distributed and when using non-parametric statistics that is the kruskal wallis test if it is not normally distributed. The results of the paired t-test obtained were interpreted according to table 6.

Table 6. Criteria for Sig Value in the Kruskal Wallis Test

Criteria	Explanation
Sig < α	There is a significant increase.
Sig ≥ α	There was no significant increase.

(Abduhan, Mulyani dan Utami)

There is a correlation between science process skills and critical thinking skills. Correlation analysis of science process skills with the ability to think critically statistically is the product moment test. The product moment test results obtained are interpreted according to table 7.

Table 7. Correlation Criteria

Interval Koefisien	Relationship Level
0,00 – 0,199	Very low
0,20 – 0,399	Low
0,40 – 0,599	Medium
0,60 – 0,799	Strong
0,80 – 1,000	Very strong

(Sugiyono, 2017)

Questionnaire responses of students are needed to find out students' responses regarding LKPD that have been made and the learning process. The response questionnaire made has a rating scale of 1 to 4. The results of the analysis conducted will be converted according to table 1.

RESULTS AND DISCUSSION

The results of the average validation score by two validators about the student worksheet developed were 3.37 according to table 1 included in the valid category.

The science process skills of each student observed during the learning process also increased which can be seen in Figure 1.

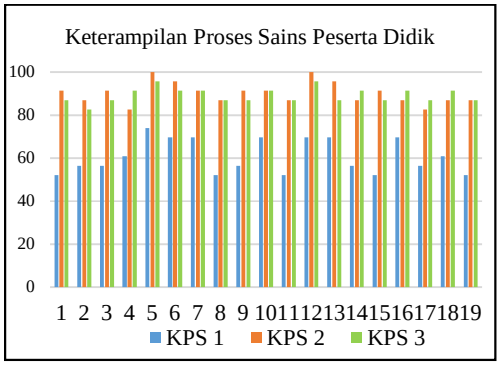

Figure 1. Graph of students' science process skills

There are also improvements to several aspects of science process skills which can be seen in Figure 2.

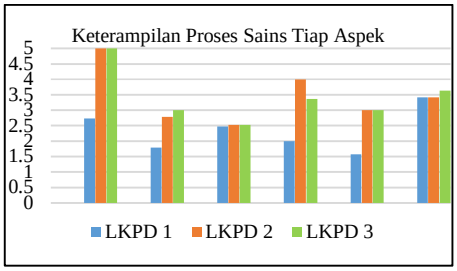

Figure 2. Science process skills for each aspect

The science process skills of students and the science process skills of each aspect are also analyzed statistically. The normality test results of science process skills of students can be seen in table 8.

Table 8. Results of normality tests of science process skills of students

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
KPS_1	,237	19	,006	,837	19	,004
KPS_2	,222	19	,015	,888	19	,030
KPS_3	,274	19	,001	,846	19	,006

a. Lilliefors Significance Correction

In the normality test for students' science process skills and science process skills every aspect is obtained sig results smaller than alpha which according to table 3 is not normally distributed. The results obtained determine that the hypothesis testing for students' science process skills and science process skills every aspect is statistically non-parametric namely the kruskal wallis test because the data are not normally distributed. Kruskal Wallis test results of students' science process skills can be seen in table 9.

Table 9. Kruskal Wallis test results of students' science process skills

Test Statistics[a,b]

	KPS
Chi-Square	38,849
Df	2
Asymp. Sig.	,000

a. Kruskal Wallis Test

b. Grouping Variable: Modul_Ke

Based on table 9, sig is smaller than alpha which according to table 6 there is a significant increase in students' science process skills. Kruskal Wallis test results for the science process skills of each aspect were obtained for aspects of the formulation of the problem, hypothesis, and drawing conclusions obtained sig smaller than alpha which according to table 6 there was a significant increase. The aspect of conducting experiments and communicating to obtain sig results is greater than alpha which according to table 6 there was no significant increase. The obstacles experienced during the study include students who are not accustomed to solving problems based on higher-order thinking skills, students who are accustomed to solving problems using formulas, and the difference in planned time with implementation time.

In addition to science process skills, students are also trained to think critically. Students' critical thinking skills are measured through the increase in N-Gain results from pre-test and post-test and also through statistical tests. The average N-Gain results obtained by students amounted to 0.39 according to table 2 including the medium category. The results of N-Gain critical thinking skills of each indicator can be seen in table 10.

Table 10. The ability to think critically for each indicator

Indikator	***Pre-test***	***Post-test***	**N-*Gain***	**Category**
Focus on question	2,53	2,74	0,1	Low
Answer the question	1,89	3,21	0,6	Medium
Analyze arguments	1,89	2,63	0,4	Medium
Make a conclusion	1	2,53	0,5	Medium
Take a decision in action	2,32	2,58	0,2	Low

Students' critical thinking skills are also analyzed statistically. The normality test results of students' critical thinking skills can be seen in table 11.

Table 11. Test results for normality of critical thinking skills

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Pre_Test	.111	19	.200*	.982	19	.959
Post_Test	.110	19	.200*	.976	19	.881

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

In the normality test for students' critical thinking skills the result of sig is greater than alpha which according to table 3 is normally distributed. The results obtained determine that the hypothesis test for students' critical thinking skills is statistically parametric, namely the two-paired t test because the data is normally distributed. The results of the two-paired t test for students' critical thinking can be seen in table 12.

Table 12. T-test results in paired critical thinking skills

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre_Test - Post_Test	-20.26316	16.28511	3.73606	-28.11233	-12.41399	-5.424	18	.000

Based on table 12, sig 2 tailed is smaller than alpha which according to table 4 there is a difference in the pre-test and post-test values. Based on table 12 the negative t value is obtained according to table 5 the post-test value is higher than the pre-test.

There is a correlation between science process skills and critical thinking skills. This can be analyzed statistically by conducting a product moment test. Correlation test results of science process skills with critical thinking skills can be seen in table 13.

Table 13. Correlation of critical thinking skills with science process skills

Correlations

		kps	Kbk
Kps	Pearson Correlation	1	,144
	Sig. (2-tailed)		,556
	N	19	19
Kbk	Pearson Correlation	,144	1
	Sig. (2-tailed)	,556	
	N	19	19

Based on table 13 obtained R of 0.144 which according to table 7 belongs to the category of very low relationship level. The correlation between critical thinking skills and science process skills obtained the level of relationship is very low due to the obstacles encountered during the study. This is relevant to research conducted by Nugraha, Arief J, et al (2017) which states that there is a strong correlation between science process skills and critical thinking skills.

The students' responses are obtained through a questionnaire that is distributed to students at the end of the meeting. Based on the results of the questionnaire that has been filled out by students regarding LKPD it can be concluded that the LKPD that is prepared has language that is easy to understand, helps the learning process, and is quite easy. The results of the questionnaire that have been filled out by students regarding the learning process can be concluded that the learning model is interesting, the learning atmosphere is fun, and the teacher's guidance helps.

CONCLUSION

Based on the research that has been done, it can be concluded that the research development of student worksheet based on guided inquiry model to train science process skills and critical thinking ability on the subject of parabolic motion in class X science 2 Saint Hendrikus Senior High School Surabaya has produce student worksheets that are valid, practical, and effective for use in the learning process. This is indicated by the results of the validation by the two validators obtaining an average score of 3.3 which is included in the valid category.

Increased students' science process skills are seen through improved graphs and statistical analysis. Students' critical thinking skills increase seen through statistical analysis and N-Gain. The average N-Gain score obtained by students was 0.39 which was included in the medium category. Good responses from students regarding student worksheet developed and the learning process that is taking place.

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