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THE EFFECTIVENESS OF INVITATION INTO INQUIRY MODEL TO STUDENTS' CRITICAL THINKING SKILLS IN DIFFRACTION GRATING MATERIAL

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Abstract

It is a fact that physics is related to the application of physic formulas and mathematic approach. Invitation into inquiry is a learning model which emphasizes on the solution of daily problem. This research aims to unveil the influence of invitation into inquiry model to students' critical thinking skills. In this research, the researcher employed mixed methods design by combining quantitative and qualitative approaches. The subject of the research is the XII grade students of SMA Negeri 2 Blora, academic year 2017/2018. The collection of the data were in the sequence of observation, tests, interview, and questionnaire. The result of the research found that the t-test obtained the significance of 0.02 or $t_{count} < t_{table}$. The most influencing indicator of critical thinking is in the ability of making hypothesis where it had the biggest gap of N-gain. The conclusion of this research showed that the model of invitation into inquiry had positive influence to students' critical thinking skills.

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INTRODUCTION

Generally, Senior High School students are not keen of physics. Prior interviews to teachers and students in SMAN 2 Blora show that physics, is identical to the application of physic formula and mathematical approach. A related example is from the material of diffraction grating where the students do not know the application of it to their real life.

The data from 4 classes: XII IPA 1, XII IPA 2, XII IPA 3, and XII IPA 4 showed that >70% students did not achieve the passing grade. The interview to students of SMAN 2 Blora found that the students had fluctuated interest to physics. Initially, when they were asked to do a task on the front white board, they only write the commonly known components like the formulas, the operation of the formulas, etc. However, they were not able to finish all the questions' items. The difficulties to answer the questions led them to be bored that they neglect the rest of the lesson.

Actually, the teaching is mostly teacher-centered (Ningsih *et al.,* 2012). The frequent use of the model should be changed to attract students to learn physics. As the facilitator, teacher has to make the students not facing the difficulties and being bored in the class (Sochibin *et al*., 2009). The learning process of physics needs experiment to make the learners understand the concepts and theories well (Astuti, 2016).

The problems above can be solved by using a model which can train the students to be active and critical. There are options of model to get the objective, including using innovative learning media and learning model. The use of media in the learning process supports the progress of getting the learning goals (Praptiwi *et al*., 2012). The current phenomena is problematic with the conflicting needs between teachers and students to build joyful learning atmosphere (Afrizon *et al*., 2012). Teachers are not the only source of learning, but they can also be the motivators and facilitators of developing students' creativity and activeness (Simbolon, 2015).

The process of inquiry learning involves students' ability to find and inspect things systematically, critically, logically, and analytically. The ability of solving problems developed by the time of human's development (Julianto *et al.*, 2013). The process of investigation done by the students in learning can be a good force to provide them a meaningful activities.

A learning model which emphasizes daily problem solving is invitation into inquiry. This learning model emphasizes students to learn and cooperate in group to find solution in their daily life. The model is expected to activate students' curiosity upon new things. Furthermore, the model can be an alternative of realizing scientific behaviour to students' daily life (Budur, 2013).

Invitation into inquiry facilitates students to investigate and solve problems in student-centered way as well as to make them able to produce real thing. In producing something, students has to have a critical mindset and accurate sight handle certain issues.

Prior researches on Invitation into inquiry have been conducted by many researches. The implementation of invitation into inquiry has been found to improve students' communicative skills effectively (Rubiyanto *et al.*, 2012). The process of students' interpretation were also improved after the application of the model (Ulya, 2014). These facts come with the same conclusion that the model directly invite students to solve issues in an inquiry-oriented activities. Besides, the model also includes higher order thinking skills, like analysis, evaluation, and creation. From these facts, the researcher interested to know the influence of invitation into inquiry model to students' critical thinking skills.

METHODS

This research employed mixed methods approach in the combination of quantitative and qualitative approaches. The design obtained data from comprehensive, valid, reliable, and objective resources.

The research also used sequential explanatory strategy. The first step of the strategy was to analyse quantitative data. The data came from pretest and posttest items. The significance of pretest and posttest come after the result of normality test. The normality test of this research using SPSS v16 resulted 0.073 for the significance of the control class and the significance of 0.186 to the experiment class. As the scores were higher than 0.05, both samples are considered having normal distribution.

The next sequence was using homogeneity test as the requirement of data analysis through comparative analysis. Later, the homogeneity test of variance showed a significance score of 0.051 (sig >0.05), or simply mean that the data of both samples are homogenous.

To measure the validity of the test item, the result of the try out were analysed using product moment correlation under the equation below:

$$r_{xy} = \frac{N\sum XY - \sum X \sum Y}{\sqrt{\{(N\sum X^2 - \sum X^2)(N\sum Y^2 - \sum Y^2)\}}}$$

Note:
r_{xy}= coefficient of correlation between X and Y
X = score of each item
Y = total score
N = number of students or subjects

This test of validity will be valid if r_{count}>r_{table}. If $r_{count} < r_{table}$, the data will not be valid with r_{table}= 0.339 for the significance of 5% (Sugiyono, 2015). From the data, the r_{count}= (0.654 – 0.390)>r_{table} = (0.361) with 5 valid statements. The questions of the researches are related to whether the activities of invitation into inquiry has relation to students' critical thinking. These queries were processed using t-test statistics. The t-test formula for normal and homogeneous data is as follows:

$$t = \frac{x_1 - x_2}{s\sqrt{\frac{1}{n_1} - \frac{1}{n_2}}}$$

with

$$s = \sqrt{\frac{\sqrt{(n_1 - 1){s_1}^2 + (n_2 - 1){s_1}^2}}{n_2 + n_2 - 2}}$$

Notes:
t = t-test
$\overline{X_1}$ = initial average score of the experiment group
$\overline{X_2}$ = initial average score of the control group
s = standard deviation from the total of initial score
S_1 = standard deviation from the total of initial score from experiment group
S_2= standard deviation from the total of initial score from the control group
n_1= number of samples in the experiment groups
n_2= number of control groups

The significance of improvement in the experiment and control class was measured using normal gain test. The formula of gain test is:

$$(g) = \frac{(S_{post}) - (S_{pre})}{100\% - (S_{pre})}$$

The total of g-factor is categorized as follows.

Table 1. Classification of N-Gain categories

No	Range of Score	Classification
1	g > 0.7	High
2	0.3 <g < 0.7	Medium
3	g < 0.3	Low

The aspects of critical thinking in the data were 1) analyzing information and clarification, 2) providing solution and ideas to issues, 3) making hypothesis and conducting experiment, 4) generalizing ideas, and 5) choosing relevant information and able to find alternatives. The categories of ability to critical thinking is in accordance with the counting of hypothetical mean and hypotetical standard deviation. The result of the measurement were classified as in Table 2 below.

Table 2. Classification of Categories to Critical Thinking Skills

Obtained Score Ranges	Criteria of Ability
0.00 – 0.66	Low
0.67 – 1.33	Medium
1.34 – 2.00	High

The analysis of qualitative data had a goal to deepen the result of quantitative analysis. To analyze the qualitative data, the researcher applied the grounded theory from Miles and Huberman. The analysis can be seen in Figure 1 as follows.

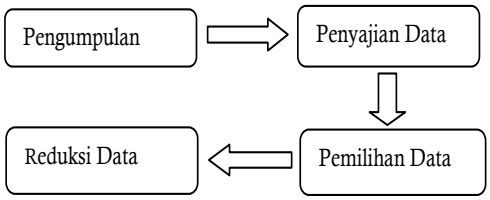

Figure 1. Analysis of Quantitative Data

RESULTS AND DISCUSSION

From the implementation of invitation into inquiry model on the experiment class to the control class, there is a change of mean to the total score of the students as seen in Figure 2 as follows.

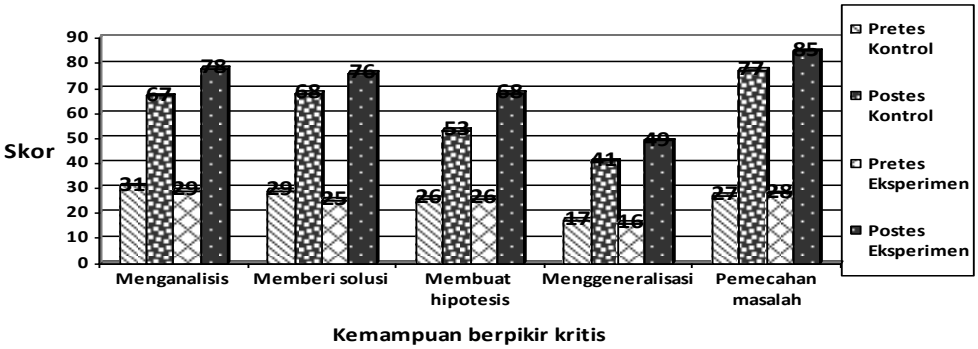

Figure 2. The Average Score of Each Indicator of Critical Thinking from the Maximum Score of 100

The indicator of making hypothesis experiences highest improvement in the chart. Based on the t-test score for the pretes and posttest score from experiment class, the data obtained the significance of 0.02 (sig < 0.05). The data mean that Ho was rejected and Ha was accepted, which means that there is an influence of critical thinking skills using invitation into inquiry model on the materials of diffraction grating.

The Ability of Critical Thinking Skills in Invitation into Inquiry Model

The division of group to the experiment group were into the groups of high, medium, and low skills. People who are able to think critically are able to evaluate and conclude based on facts (Dwijananti *et al.*, 2010). In higher order critical thinking, students are able to connect, manipulate, and transform knowledge (Rofiah *et al.*, 2013).

In this case, the data came from critical thinking test and interview test. The indicator of critical thinking skills were analysed, including to:

Making hypothesis and conducting experiments

The ability of critical thinking in the indicator of making hypothesis is projected in Figure 3.

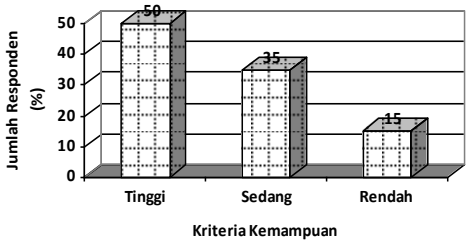

Figure 3. The ability of critical thinking in making hypothesis and conducting experiment

It is seen in Figure 3 that the indicator of making hypothesis, the students of high, medium, and low categories have very similar gap. Even though it is similar, there is still some students who face difficulties on that.

The scientific working performance are highly required in the testing, since the performance is strongly influenced by processing skills and students' scientific behaviour. Students with high ability are able to construct their own knowledge. The low performance of students' scientific shows low motivation of students to learn (Dewi *et al.*, 2013)

Generalizing ideas or perspective on something

This indicator has the lowest score to the other. The low score is mainly caused by the less maximum ability of students to identify and assume things. The data of this indicator is delivered in the following Figure 4.

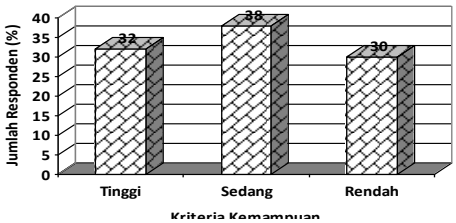

Figure 4. Ability of critical thinking on generalizing ideas or perspective on something

Riyanti *et al.* (2016) states that the process of revealing ideas will be better if people work on discussion. However, it can be seen in Figure 4 that the number of students with high, medium, and low level of this category is similar. The fact shows that some students still experiences confusion in generalizing and evaluating ideas. The lack of training in evaluating making students have low critical thinking skills (Snyder *et al.*, 2008).

Physics learning will be more meaningful through direct learning. The ability of critical thinking needs the activation of students in

learning (Setiawan, 2008). Another obstacle of this indicator is that not all students are active in the classroom (Praptiwi *et al*., 2012).

Based on Figure 2, it can be concluded that invitation into inquiry has influence to students' critical thinking skills. It shows that the learning model makes students involved in the activities which needs strong cognitive skills.

The result of Luthvitasari *et al.* (2012), and Sochibin *et al.* (2009) show that inquiry can improve students' critical thinking skills seen from the difference of significance from the test results. Similar research is conducted by Megantara *et al.* (2013). The research found that invitation into inquiry was effective to improve students' critical thinking ability. In Nikmah *et al.* (2017), in the subject of computer study, students obtained better results after the application of invitation into inquiry model than using the expository model. The result is contradicting to Ulya (2014). She finds that the effectiveness of the model is not shown after the application of it to the computer class in improving students' interpreting skills.

CONCLUSION

Based on the results and discussion, it can be concluded that the use of invitation into inquiry influence students' critical thinking skills. The statement is proven by the result of t-test with the significance of 0.02 (sig < 0.05).

Based on several suggestions, there are some suggestions proposed: (1) From the gap of score, the score of the experiment class was higher than the control class; it proves that the model is effective to be an alternative for teachers. (2) There should be an attentive careness on making invitation to students to attract their interest on solving problems, specifically in asking questions, formulating hypothesis, and planning experiment. (3) The teacher should motivate students to read the materials in advance to provide the preview on making hypothesis regarding the materials.

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