Analysis of critical and creative thinking skills on the topic of static fluid physics with guided inquiry learning assisted by computer simulation

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Abstract. This study aims to analyze student’s critical thinking skills and creative thinking skills on the topic of static fluid physics using guided inquiry learning assisted by computer simulations. This type of research is a quasi experiment with the design of three groups pretest-posttest. The sampling technique uses cluster random sampling. Analysis of research data using multivariate analysis of variance (Manova). The results showed that student’s critical thinking skills and creative thinking skills on the topic of static fluid physics using guided inquiry learning assisted by computer simulations were better than using guided inquiry learning without assisted by computer simulation or conventional learning.

1. Introduction
The 2013 curriculum which is implemented in the 21st century is very important and decisive in preparing the future of the nation's children. The 2013 curriculum emphasizes the importance of student’s having higher order thinking skills. Higher order thinking skills will make student’s accustomed to facing something difficult. Student’s who are able to think at a higher level will be able to compete in a globalized world.

Student’s basically have curiosity, which means that student’s already have an innate scientific attitude, it's just that they are not well directed [1]. The guided inquiry learning model is a teacher-guided inquiry that allows student’s to gain depth of understanding and personal perspective through various sources of information [2]. Intellectual skills that exhibit HOTS such as analysis, evaluation and creation help stimulate student’s to inquire which leads to deep knowledge and deepening [3]. In addition, learning using computer simulation-based media such as PhET and Adobe Flash can improve student’s critical thinking skills on static fluid material [4]. The effective application of the guided inquiry learning model and supported by computer simulation media is expected to improve student’s critical and creative thinking skills [5].

2. Method
The sample in this study consisted of 3 classes that were randomly selected by using cluster random sampling technique. The first sample is the experimental class I (the class that applies the guided inquiry learning model assisted by computer simulations), the second sample is the experimental class II (the class that applies the guided inquiry learning model), and the third sample is the control class (the class that applies conventional learning). In the three sample classes, the pretest was carried out first, then the data from the pretest results were seen for homogeneity and normality. Furthermore, the
three classes were given treatment before finally being given a posttest. The results of the posttest of the three classes were also tested for normality and homogeneity, before finally the research hypothesis was tested using the Multivariate Analysis of Variance (MANOVA) test.

3. Results and Discussion
The results of the pretest conducted in the three sample classes showed that the three sample classes studied were normally distributed as shown in Table 1 and Table 2 below.

| Class          | Shapiro-Wilk Statistic | df  | Significance |
|----------------|-------------------------|-----|--------------|
| Control        | 0.961                   | 36  | 0.235        |
| Experiment I   | 0.950                   | 36  | 0.105        |
| Experiment II  | 0.959                   | 36  | 0.195        |

The results of the normality test output using the Shapiro-Wilk test in table 1 show the significance value of the pretest data for critical thinking in the control class is 0.235, the experimental class I is 0.105, and the experimental class II is 0.195. The significance value of the three classes is greater than 0.05, so it can be concluded that the critical thinking data in both the experimental class and the control class are normally distributed.

| Class          | Shapiro-Wilk Statistic | df  | Significance |
|----------------|-------------------------|-----|--------------|
| Control        | 0.974                   | 36  | 0.549        |
| Experiment I   | 0.950                   | 36  | 0.105        |
| Experiment II  | 0.950                   | 36  | 0.105        |

The results of the normality test output using the Shapiro-Wilk test in table 2 show the significance value of the pretest data for creative thinking in the control class is 0.549, the experimental class I is 0.105, and the experimental class II is 0.105. The significance value of the three classes is greater than 0.05. So the creative thinking data in both the experimental class and the control class are normally distributed.

The results of the pretest carried out in the three sample classes also showed that the three sample classes studied were homogeneous as shown in table 3 below.

| Class          | Levene’s Statistic | df1 | df2  | Significance |
|----------------|--------------------|-----|------|--------------|
| CRITICAL       | 0.006              | 2   | 105  | 0.994        |
| CREATIVE       | 0.470              | 2   | 105  | 0.627        |

The results of the homogeneity test of critical thinking skills and creative thinking skills in table 3 show that the significance values are 0.994 and 0.627. The significance value is greater than 0.05, it is concluded that the pretest data for critical and creative thinking skills in the control class and experimental class have the same variance and can represent the entire population.

After the three sample classes were given treatment and given a posttest, the normality and homogeneity tests were also carried out on the post-test results of the three classes as a condition for
testing the research hypothesis. The results of the normality test results are shown in Table 4 and Table 5 below.

**Table 4.** Pretest Data Normality Test for Critical Thinking Skills Control and Experimental Classes.

| Class      | Shapiro-Wilk Statistic | df  | Significance |
|------------|------------------------|-----|--------------|
| Control    | 0.954                  | 36  | 0.136        |
| Experiment I | 0.947              | 36  | 0.083        |
| Experiment II | 0.951           | 36  | 0.114        |

The results of the data normality test for critical thinking skills in table 4 above show that the significance value of the post-test data for the control class is 0.136, the experimental class I is 0.083, and the experimental class II is 0.114. The significance value of the three classes is greater than 0.05 so that the data in the control class and experimental class are normally distributed.

**Table 5.** Pretest Data Normality Test for Creative Thinking Skills Control and Experimental Classes.

| Class      | Shapiro-Wilk Statistic | df  | Significance |
|------------|------------------------|-----|--------------|
| Control    | 0.948                  | 36  | 0.088        |
| Experiment I | 0.954              | 36  | 0.138        |
| Experiment II | 0.950           | 36  | 0.104        |

The results of the normality test of the post-test data for creative thinking skills in table 5 above show that the significance value of the post-test data for the control class is 0.088, the experimental class I is 0.138, and the experimental class II is 0.104. The significance value of the three classes is greater than 0.05, so it can be concluded that the data in the control class and experimental class are normally distributed.

The homogeneity test results of the post-test results of the three sample classes as a prerequisite before the hypothesis testing was carried out, is shown in table 6 below.

**Table 6.** Homogeneity Test of Posttest Data for Critical and Creative Thinking Skills for Control and Experimental Classes.

|          | Levene’s Statistic | df1 | df2 | Significance |
|----------|--------------------|-----|-----|--------------|
| CRITICAL | 1.785              | 2   | 105 | 0.173        |
| CREATIVE | 1.986              | 2   | 105 | 0.142        |

The results of the homogeneity test of critical thinking skills in table 6 above indicate that the significance value for critical thinking skills is 0.173 and creative thinking skills is 0.142. The significance value of the three classes for critical and creative thinking skills is greater than 0.05, so it can be concluded that the post-test data for critical and creative thinking skills in the control class and experimental class have the same variance and can represent the entire population.

Hypothesis testing of post-test data for critical and creative thinking skills is done by testing the similarity of the three post-test scores using the Manova test at the 0.05 significance level. The results of the post-test data analysis are shown in table 7 below.
Table 7. Manova Test Postest Data for Critical and Creative Thinking Skills Control Class and Experiment Class.

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F     | Sig.  |
|--------|---------------------|-------------------------|----|-------------|-------|-------|
| CLASS  | CRITICAL            | 2334.889                | 2  | 1167.444    | 5.306 | 0.006 |
|        | CREATIVE            | 2328.000                | 2  | 1164.000    | 6.793 | 0.002 |

The significance value of critical thinking skills obtained according to table 7 with the Manova test is 0.006. The significance value is smaller than 0.05, so H₀ is rejected and Hₐ is accepted so that the critical thinking skills of student’s who are taught using guided inquiry learning assisted by computer simulations are better than the critical thinking skills of student’s taught using guided inquiry learning without the help of computer simulations and conventional learning models. The significance value of creative thinking skills obtained according to table 7 with the Manova test is 0.002. The significance value is smaller than 0.05, so H₀ is rejected and Hₐ is accepted so that the creative thinking skills of student’s who are taught using guided inquiry learning assisted by computer simulations are better than the creative thinking skills of student’s taught using guided inquiry learning without the help of computer simulations and conventional learning models [6].

The relationship between the dependent variables, namely critical thinking skills and creative thinking skills, is shown in table 8 below.

Table 8. Correlation Between Bound Variables.

| Correlation | CRITICAL | CREATIVE |
|-------------|----------|----------|
| CRITICAL    | 1.000    | 0.901    |
| CREATIVE    | 0.901    | 1.000    |

Table 8 above shows that the correlation between the two variables, namely critical thinking skills and creative thinking skills, results in the number 0.901, so it can be concluded that there is a very strong relationship between critical thinking skills and creative thinking skills. The correlation result with the Manova test shows that student’s who are skilled in critical thinking will also be skilled in creative thinking and vice versa. The correlation obtained is that if critical thinking skills have increased, creative thinking skills will also increase.

The results obtained in this study indicate that there are differences in student’s critical and creative thinking skills in the experimental class I using the guided inquiry learning model assisted by computer simulations, the experimental class II using the guided inquiry learning model and the control class using conventional learning. Learning science has actually been ineffective for a long time if it continues to be taught in a conventional way either by lecturing or discussion methods because student’s needs have shifted as a form of learning outcomes [7].

Student’s critical thinking skills in stating problems, formulating hypotheses, collecting data, analyzing them and making conclusions based on problems are better using guided inquiry learning assisted by computer simulations. Teaching and learning to use inquiry models can improve student’s critical thinking skills and understanding in data analysis. This is indicated by the increase in the average score of student’s critical thinking skills from the pretest and posttest for each indicator. The instrument of critical thinking skills given to student’s measures five indicators of critical thinking skills, namely providing simple explanations, building basic skills, making conclusions, making further explanations, and arranging strategies and tactics. Student’s critical thinking skills have not been categorized as very good because student’s are still not used to carrying out the steps in inquiry learning. Student’s still need time to practice. Some student’s find the problem is that it is difficult to express skills. Student’s face some difficulties in linking the problem statement with the hypothesis.
The ability to collect data can be categorized as sufficient due to the way student’s learn before and the limited learning resources from the natural environment. One of the difficulties in implementing guided inquiry-based learning is the assumption that in learning, the only source of knowledge is the teacher. The teacher explains everything; thus, student’s do not have to go out to find them on their own. Learning habits like this cause student’s to find it difficult when they are asked to solve problems. They will find it difficult to ask and answer questions from the teacher. This can be overcome if student’s are given enough time to find answers to a question [8].

The use of learning media in the form of computer simulations gives positive results on student’s critical thinking skills. Giving computer simulations gives student’s an understanding of the basic concepts of static fluid material independently and raises student’s critical thinking skills. In accordance with the guided inquiry learning stages, student’s are required to be able to develop problem solving ideas independently with teacher guidance. The problem given is on the student worksheet. The problem was answered by collecting data through experiments. The basic concepts that student’s have obtained through computer simulations before collecting data help student’s to be able to set strategies and tactics regarding what steps to take in the experiment, how to arrange the correct series of experiments, and after the data has been collected, student’s are able to understand whether the data obtained is appropriate or not. not with the basic concept of static fluid that they have obtained through the given simulation media. Student’s become able to provide simple explanations and build basic skills in answering problems until they are finally able to draw conclusions based on experimental results which show the emergence of student’s critical thinking skills in learning using computer simulations. The results showed that the average value of student’s critical thinking skills in the experimental class I who were taught using guided inquiry learning assisted by computer simulations was better than student’s in the experimental class II who were only taught using guided inquiry learning. Student’s critical thinking skills in experimental class I are better because the use of computer simulations can stimulate and support each indicator of critical thinking skills that student’s can achieve better than if they do not use computer simulations.

The results showed that student’s creative thinking skills in the experimental class I improved better than the experimental class II and control classes. The increase in the average value of student’s creative thinking skills with guided inquiry learning assisted by computer simulations in experimental class I is better because through guided inquiry learning there is a process for diagnosing problems, criticizing experiments, and distinguishing alternatives, planning investigations, researching conjectures, looking for information, building models, argue with peers, and form coherent arguments. The whole process is a very good process for developing student’s thinking skills, especially for creative thinking skills and is not fully accommodated in conventional learning models [9]. Guided inquiry learning is able to improve student’s creative thinking skills when student’s are required to be able to independently find new ideas to answer problems regarding static fluid material provided by the teacher, especially in carrying out experiments. Student’s are only given the tools and materials needed as a step to find solutions to problems. As a group, student’s are seated to share their ideas with each other. Group activities show the first aspect of critical thinking skills, namely fluency, namely whether all group members can provide ideas that are relevant or not according to the problem of static fluid material. Flexibility appears when student’s in groups are able to provide more than one solution or not, for example in determining how to assemble Pascal's law experiments, whether a series of experimental tools can vary but still produce the same solution to answer a problem. Elaboration appears when the answers given by student’s in groups are correct and detailed. Originality appears when student’s provide solutions in their own different and interesting ways or simply follow solutions that are still common.

The correlation results from the Manova test conducted to determine the relationship between variables can be seen that the correlation between critical thinking skills and creative thinking skills results in the number 0.901. The correlation value of 0.901 is between 0.800 - 1.000 so it can be concluded that there is a very strong correlation between critical thinking skills and creative thinking skills. The relationship between critical thinking skills and creative thinking skills is also positive,
which means that if critical thinking skills are higher, creative thinking skills will also be higher and vice versa. Creativity and critical thinking are one-sided thinking like two sides of the same coin. Creativity skills can be achieved by first pursuing critical thinking skills so as to be able to detail questions concerning the problem, evaluate or assess, and generate considerable curiosity [11].

4. Conclusion

Based on the studies that have been conducted, it is concluded that there is an effect of the guided inquiry learning model assisted by computer simulations on student’s critical and creative thinking skills. There is also a very strong relationship between student’s critical and creative thinking skills through the application of the guided inquiry learning model assisted by computer simulations.

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