The effect of guided inquiry based hypermedia on students’ high order thinking skills in thermodynamics concepts

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Abstract. Thermodynamics is a concept in physics that is considered difficult. This is because the students have to use high order thinking skills. Meanwhile, some research results indicate that students’ high order thinking skills are still low. In this study, guided inquiry based hypermedia was applied to hone students’ high order thinking skills on thermodynamics concepts. This research was conducted at SMA Islam Terpadu Mentar illmu Karawang in April 2020. Quasi-experimental was used as a method in this research. The research sample was class XI students who were grouped into the experimental class and the control class. The test instruments used were essay questions and non-test instruments used were questionnaires. The N-gain result shows that the posttest mean score of the experimental class increased. However, the increase was categorized as moderate. Hypothesis testing shows that there is an effect of guided inquiry based hypermedia on students’ high order thinking skills. Meanwhile, the results of the questionnaire showed that learning using hypermedia based on guided inquiry received a positive response from students and was categorized as very good (83%).

1. Introduction

Physics is a branch of science that explains phenomena that occur in everyday life. Studying phenomena in everyday life should be an interesting thing for students to study physics. However, in general students do not like learning physics. Rosyidah, et al. revealed that students' interest in learning physics is at a low level. Lack of student interest because students find physics concepts difficult to understand[1]. One of the physics concepts that is considered difficult is thermodynamics concepts[2]. Based on Suroso's research, the difficulty in understanding the concept of thermodynamics is due to the characteristics of the thermodynamic discussion which is difficult and confusing, namely the concept of environment-to-system ventures and vice versa, and there are many formulas that must be studied by students[3]. According to Nadhiroh in his research, to overcome the difficulties in understanding the thermodynamic concept, students must have higher order thinking skills[2]. High order thinking skills are thinking skills that not only needs ability to remember, but also higher abilities such as analyze, evaluate, and create[2]. Students' high order thinking skills need to be trained in learning process[4].

In fact, there are some obstacles found in improving students' high order thinking skills such as, first, teachers role is more dominant. Second, teachers consider that students are a container that will be filled with knowledge. Third, more students' achievement systems tests that test low-order thinking skills[5]. In order to train students’ high order thinking skills, it is needed a medium that can help teacher in learning process. One of media that can be a solution is hypermedia.
Hypermedia is a system for integrating graphic, sound, video, and animation into a document or file linked by a system called hyperlink[6]. The functions of link are to ease users to open wanted files and either back to previous or next file as you want. However, the use of hypermedia is not enough to improve students' high order thinking skills so that it is needed strategies while implementing hypermedia. One of strategies that can be used in order to improve students' high order thinking skills is using inquiry model[7].

Inquiry model is a learning that not only improve students' intellectual abilities, but all students' potentiality[8]. The inquiry model that is used as the basis of hypermedia is the guided inquiry model. The selection of guided inquiry model is based on the fact that guided inquiry model can invites students to explore their abilities, learn to analyze, and be active on the concept or principle they are studying[9]. Furthermore, the guided inquiry model also makes teacher as a main controller without fully involved in learning process in order to be structured[10].

2. Methods
This study was conducted in SMA IT Mentari Ilmu Karawang that is located in perumahan karab I, Blok Kios, Teluk Jambe Timur, Karangang on even semester of year 2019/2020. This study used quasi-experimental method. The quasi-experimental method aims to determine the effect of a particular action or treatment[11]. Nonequivalent control group was used as design of the study. Target population of this study was all students of SMA IT Mentari Ilmu Karawang, while accessible population of this study was all eleventh graders of SMA IT Mentari Ilmu Karawang. Samples of this study were two classes of eleventh grade and divided into controlled and experimental class. Data collection techniques consisted of high order thinking skills test and questionnaire. High order thinking skills test was given on pre-test and post-test of experimental and controlled class. Meanwhile, questionnaire was given to experimental class at the end of the lesson. Data were analyzed using requisition analysis and statistical hypothesis testing with software SPSS 23.

3. Result and Discussion
3.1. The result of students' high order thinking skills based on pre-test and post-test of experimental and controlled class
The high level thinking ability of eleventh grade students of SMA Islam Terpadu Mentari Ilmu Karawang in terms of thermodynamics is still low. It can be seen on pre-test result in which mean scores of both experimental and controlled class are in very low range. However, after being given treatments the scores of two classes have improved. Moreover, the result of students' high order thinking skills based on pre-test and post-test of experimental and controlled class can been seen in following Chart 1.

Based on chart 1 shows that the result of pre-test and post-test of students' high order thinking skills of experimental and controlled class experiences an improvement. The highest improvement of experimental and controlled class is in ability to analyze (C4). The improvement of ability to analyze of experimental class is 49%, while controlled class is 38%. Meanwhile, the lowest improvement of experimental and controlled class is in the ability to create (C6). The improvement of the ability to create (C6) of experimental class is 40%, while controlled class is 25%. It means that either experimental or controlled class experiences an improvement in each high order thinking skills' indicator. However, the increase in the average score of the experimental class treated with learning using guided inquiry-based hypermedia media was better than the control class given conventional learning. This result is in line with Erlin Montu's research, that the average score of students who use hypermedia is better than students who use real media. Meanwhile, Muhdana et al's research shows that the average score of students who use guided inquiry-based learning is better than conventional learning[12].
The result of students' high order thinking skills based on pre-test and post-test of experimental and controlled class.

The result of normality test of pre-test and post-test can be seen in the following Table 1.

**Table 1.** Result of normality test of pre-test and post-test of experimental and controlled class.

| Statistik                  | Pretest       | Posttest     |
|----------------------------|---------------|--------------|
|                            | Experimental  | Controlled   | Experimental | Controlled   |
| Df                         | 27            | 27           | 27           | 27           |
| Sig. (2-tailed)            | 0,012         | 0,039        | 0,082        | 0,020        |
| Significance level (α)     | 0,05          | 0,05         |              |              |
| Conclusion                 | Abnormally distributed data | Abnormally distributed data | Normally distributed data | Abnormally distributed data |

The result of homogeneity test of pre-test and post-test can be seen in the following Table 2:

**Table 2.** Result of homogeneity test of pre-test and post-test of experimental and controlled class.

| Statistic                  | Pre-test of experimental and controlled class | Post-test of experimental and controlled class |
|----------------------------|-----------------------------------------------|-----------------------------------------------|
| Levene Statistic           | 0,458                                         | 1,011                                         |
| Sig. (2-tailed)            | 0,502                                         | 0,319                                         |
| Significance Level (α)     | 0,05                                          | 0,05                                          |
| Conclusion                 | Both classes are homogenous                    | Both classes are homogenous                    |
The results of normality and homogenity test show that both pre-test and post-test are distributed abnormally and homogeneous. Therefore, this study uses nonparametric statistical hypothesis test that is Mann-Whitney test with SPSS 23.

The result of hypothesis test of pre-test and post-test can be seen in the following Table 3.

Table 3. Result of hypothesis test of pre-test and post-test of experimental and controlled class.

| Statistic | Pre-test | Post-test |
|-----------|----------|-----------|
| Sig. (2-tailed) | 0.217 | 0.0000 |
| Significance Level (α) | 0.05 | |
| Conclusion | H₀ is accepted | H₁ is accepted |

Table 3 shows that pre-test result has significant score (2-tailed) > significant level (α), so null hypothesis is accepted. It means that before being given treatment there is no effect of guided inquiry based hypermedia on students' high order thinking skills. Meanwhile, post-test result has significant score (2-tailed) < significant level (α), so alternative hypothesis is accepted. It means that after being given treatment there is effect of guided inquiry based hypermedia on students' high order thinking skills.

3.2. The general description of improvement of students' high order thinking skills

The general description of improvement of students' high order thinking skills as shown in following Table 4.

Table 4. The improvement of high order thinking skills based on N-gain result of experimental and controlled class.

| Number | High Order Thinking Skills | Experimental Class | | Controlled Class | |
|--------|---------------------------|--------------------|-----------------|-----------------|-----------------|
|        | Pr- test | Post-test | N-Gain | Category | Pre-test | Post-test | N-Gain | Category |
| 1.     | Analysis (C4) | 10 | 6 | 303 | 0,49 | Medium | 101 | 254 | 0,37 | Medium |
| 2.     | Evaluation (C5) | 51 | 172 | 0,45 | Medium | 62 | 165 | 0,38 | Medium |
| 3.     | Create (C6) | 74 | 234 | 0,40 | Medium | 94 | 194 | 0,25 | Low |

Table 1 shows that the improvement of students' high order thinking skills of experimental class in all abilities is in medium category. Moreover, the improvement of students' high order thinking skills of controlled class in ability to analyze (C4) and evaluate (C5) are in medium category, while ability to create (C6) is low. Based on the explanation above, after being given different treatments either experimental or controlled class experiences an improvement. However, the improvement of experimental class is higher than controlled class in each ability. If we look at the N-Gain result shows that learning with guided inquiry based hypermedia improves each category of high order thinking skills such as analyze (C4), evaluate (C5), and create (C6).

In ability to analyze (C4), both experimental and controlled class experience an improvement. But, the ability to analyze of experimental class is better than controlled. It is because hypermedia is
designed with inquiry-based learning (investigation). The way of thinking that is used in inquiry learning can train critical thinking skill and ability to analyze (C4). This is in line with Hosnan's statement that the way of thinking used in inquiry learning can train critical thinking skills and analytical skills (C4)[13].

The ability to analyze (C4) has three indicators that is distinguishing, organizing, and attributing. In this study, those indicators experience an improvement after being given learning using guided inquiry based hypermedia. It is because, in hypermedia, students are trained to choose tools that are going to use and arrange appropriately while doing an experiment. This activity makes students are able to distinguish and organize. Also, students are doing an experiment in order to gain information. This activity trains students to attribute. According to Anderson and Krathwohl, in the activity of sorting tool parts according to their overall structure, they can practice differentiation skills. Furthermore, Anderson and Krathwohl stated that recognizing and arranging a structure appropriately can train organizational skills. Meanwhile, R. Arifin Nugroho stated that the activity of obtaining information and determining points of view can train the ability to attribute.

In ability to evaluate (C5), either experimental or controlled class experience an improvement. It is because in experiment part of hypermedia, students are facilitating to do a recheck on analysis results by filling up provided score columns. In this activity, students can draw a conclusion based on analysis result of the experiment being done. According to Anderson and Krathwohl, the ability to evaluate can be trained by activities that guide students to make decisions and set quantitative standards.

Two indicators of the ability to evaluate experience an improvement that is examining and criticizing. It is because on hypermedia is given a problem that guides students doing an appropriate experiment and examining hypothesis. According to Hesti Cahyani, giving problems that lead students to produce appropriate information can practice checking skills[14]. Moreover, on hypermedia is given a feedback such as evaluation questions that can train students in solving problems and assessing a process based on problems (criticize). If we look at the questionnaire, 80% of students states that evaluation questions on hypermedia is effective to train students in solving problems.

Besides ability to analysis (C4) and evaluate (C5), ability to create (C6) also experiences an improve in each indicator that is formulating, planning, and producing. It is caused by hypermedia facilitates students to make a hypothesis of a fact and phenomenon on columns provided. This activity trains students to formulate. Furthermore, hypermedia also facilitates students to make experimental steps in the column provided. This activity trains students to plan. Moreover, students can do an experiment and analyze data to overcome a problem. This activity trains students to produce. According to Amna Emda, facilitating students in observation activities, determining the tools used for important variables and determining steps to create real solutions to a problem, can train the ability to formulate and plan[15]. Meanwhile, Anderson and Krathwohl stated that, when planning to solve a problem, students can practice their production skills.

Overall, guided inquiry-based hypermedia facilitates students to hone higher order thinking skills. In hypermedia, there are also questions that hone students' higher order thinking skills, one of which is,"Ani lives in the peak area, she prefers to drink hot tea in the morning. Meanwhile, Nabila lives in Jakarta, she prefers to drink iced tea in the morning or evening. Why do you think they like different drinks. Explain using thermodynamic concepts!". The question is a question that in fact we often see. In this question, there are many things that students can explain after students study thermodynamics, including the zero law of thermodynamics where the system will naturally reach temperature equilibrium with its environment. On this question, guide students to hone their knowledge and be able to convey their knowledge based on their point of view and provide results in the form of conclusions. In other words, this question can hone high-order thinking skills.

Besides being able to hone higher order thinking skills, Hypermedia also received positive responses from students and was categorized very well with a percentage of 83%. The calculation result of questionnaire as shown in Chart2.
Based on Chart 2 shows that the use of guided inquiry based hypermedia in learning is in very good category. Also, the effect of guided inquiry based hypermedia on students' high order thinking skills is in very good category. It means that the implementation of guided inquiry based hypermedia in learning gets positive responses from students.

In this study, hypermedia is designed with guided inquiry learning in which learning is based on students' center. Learning that oriented on students' center is effective in enhancing students' high order thinking skills [5]. Directly involved in learning process, students can acquire abilities that can last a long time in themselves [15]. From some advantages that have been enclosed above, it can be concluded that guided inquiry based hypermedia has effects on students' high order thinking skills in thermodynamics concepts.

4. Conclusion
The results of the study concluded that there was an effect of guided inquiry-based hypermedia on students' higher order thinking skills. This can be seen in the statistical hypothesis test of the posttest data which shows the value of Sig. 2-tailed (0.001) < significance level (0.050). In addition, the N-Gain results showed that the posttest mean score of the experimental class had increased in the moderate category. Meanwhile, the results of the questionnaire showed that learning using hypermedia based on guided inquiry received a positive response from students and was categorized as very good (83%).

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