Implication of thinking maps assisted inquiry model for higher order thinking skills (HOTS) on chemistry

E Kharismayuni¹, T Feronika¹, L Yunita¹
¹Department of Chemistry Education, Faculty of Educational Sciences Universitas Islam Negeri Syarif Hidayatullah Jakarta, Indonesia

E-mail: ekakharismayuni21@gmail.com, tonih.feronika@uinjkt.ac.id, luki.yunita@uinjkt.ac.id

Abstract. The 2013 curriculum emphasizes a learning system that can build students HOTS. The Inquiry Model is known to increase HOTS. Even though it is effective for increasing HOTS, the Inquiry model has shortcomings so Thinking Maps are needed. The research objective was to determine the effect of the use Inquiry model assisted by Thinking Maps on HOTS in chemistry. The research method used a Quasi Experiment with a research design of Non equivalent Pretest and Posttest Control. The research design group consisted of a control and experimental group. The research sample involved students of class X MIPA 1 and MIPA 2 in high schools at Depok with a total sample of 25 students who were taken using purposive sampling technique. The data were obtained from 25 multiple choice instruments of HOTS. The results of the posttest hypothesis test using the Independent Sample T Test indicate that the Sig. 2-tailed is 0.021 < α (0.05), which means it is accepted. The results of the data obtained were then analyzed. The results showed that there were implications for the Inquiry learning model assisted by Thinking Maps on HOTS in chemistry. The Thinking Maps assisted Inquiry Model can train HOTS on students.

1. Introduction

Education is an effort made by society and the nation in a conscious and structured manner in developing the potential of students and to prepare the younger generation for the continuity of a better life for the community and nation in the future [1]. Updates in various fields of education are always carried out in order to improve the quality of education in Indonesia, one of the government's efforts to improve the quality of education, namely by developing the 2013 Curriculum through the Ministry of Education and Culture [2]

The 2013 curriculum is a curriculum that is strived to provide the best service for students to be able to think creatively, independently, and innovatively. The 2013 curriculum emphasizes a learning system that can build Higher Order Thinking Skills (HOTS) of students [3]. The implementation of learning based on the 2013 curriculum is closely related to Higher Order Thinking Skills (HOTS) in which students are directed to be able to have Higher Order Thinking Skills (HOTS) in determining solutions to problems faced [4].

According to Newman and Wehlage in Widodo, through HOTS students will be able to convey their arguments well, solve problems, and be able to understand complex things to become clearer things. However, what becomes a problem in practice is that often a teacher makes a HOTS question, but in the implementation of learning a teacher does not emphasize learning using Higher Order Thinking Skills (HOTS) [4]. Teachers dominate the learning process activities while students become
more passive so that the activities of students during the teaching and learning process are low, thus learning becomes unattractive to students and learning becomes ineffective[5].

The implementation of chemistry learning that is carried out by the teacher must choose a model that can foster student HOTS and in accordance with the objectives to be achieved in learning activities. The learning model used must be able to engage students and find new constructive concepts for themselves. One learning model that involves and trains students to learn to discover is inquiry-discovery learning [6]. In accordance with the implementation of the 2013 Curriculum according to Permendikbud Number 65 of 2013 concerning Process Standards, the learning model that is expected to shape scientific, social behavior and develop a sense of curiosity is the Inquiry Based Learning model, discovery learning model (Discovery Learning), learning model based projects (Project Based Learning), and problem-based learning models (Problem Based Learning) [2].

Inquiry learning in learning activities not only places students as learning subjects through verbal teacher explanations (lectures), but they are required to find their own concepts from the material being studied by reasoning logically and critically which is used to solve a problem in life or study material others in various domains of science [7].

Research has proven a lot about the effectiveness of inquiry learning, but several studies have also addressed the weaknesses of inquiry-based learning. Kirschner, Sweller, and Clark stated that learning with minimal guidance, for example inquiry-based learning, cannot work [8] because inquiry-based learning can create a cognitive load that can actually hinder the learning process of students, especially lay students who still don't have a scheme. to integrate new information with the knowledge they already have. Other deficiencies that may occur are incomplete understanding or knowledge or information that is not well structured. To cover any shortcomings that might occur from using the inquiry model, visual aids can be used as described by Hyerle (2008) [8] that visual mapping is one of the techniques for structuring information previously known by students.

One of the newer types of visual mapping is thinking maps. Thinking map means "innovative thinking" which provides students with thinking skills. The purpose of Thinking Map is to produce human resources who have critical, creative, innovative and competitive thinking in the future [9]. Meanwhile, according to Holzman, thinking maps can help all children, regardless of their main learning style, be it kinesthetic, auditory, or verbal. Thinking maps can be effectively used to support Higher Order Thinking Skills (HOTS) [10].

According to the results of research conducted by Ping (2017) it shows that applying the HOTS concept through thinking maps is beneficial for students to minimize error making when solving math questions and prove that the middle and lower classes are able to master mathematical concepts through thinking maps in concepts HOTS [11]. Whereas in other studies it was concluded that inquiry-based learning with the assistance of thinking maps can improve and develop Higher Order Thinking Skills because inquiry learning assisted with thinking maps can create a conducive learning environment where students are free to create and develop their understanding [8].

2. Literature Review

Higher Order Thinking Skills (HOTS) according to King, Goodson and Faranak (1997), human thinking skills can be classified into two, namely low-level thinking skills (LOTS) and high-order thinking skills (HOTS). Higher Order Thinking Skills (HOTS) include critical, logical, reflective, metacognitive, and creative thinking. They are activated when the individual faces an unfamiliar problem, uncertainty, question, or dilemma. [8]

Higher Order Thinking Skills (HOTS) is thinking that trains the cognitive abilities of students at a higher level, namely students are able to combine facts and ideas in the process of analyzing, evaluating to the stage of making in the form of providing an assessment of a fact that is learned or can create from something that has been learned creatively [9]. According to Saputra (2016), he explains that Higher Order Thinking Skills (HOTS) is a thinking process of students at a higher cognitive level developed from various cognitive concepts and methods and learning taxonomies [10]. HOTS occurs when someone gets new information, stores, organizes, and relates it to existing knowledge and then
passes the information on to achieve a specific object or solution to a problem. HOTS involves cognitive skills, namely skills to analyze, synthesize, evaluate and generate new ideas. HOTS makes people use facts and make connections between other facts or concepts, manage to categorize them, manipulate them and apply them to new solutions to other situations [11].

Brookhart (2010) states that the Higher Order Thinking Skills (HOTS) indicator consists of analyzing, creating, reasoning and logic, making decisions, creativity and creative thinking [12]: (1) Analysis, Evaluation, and Creating, analysis students can read from the information into smaller parts on the grounds of the information. Students can state that that is supported by evidence. The ability to create learners can be from uniting different things in new ways or re-discussion of existing information to create new things, (2) Reasoning and Logic, reasoning ability is the ability of students to judge the truth of a logical fact, namely the decision of reasoning, (3) Decisions, decisions taken by students can take from a data the truth from a source and implied assumptions, (4) Problem solving, students' problem solving abilities can be from identifying a problem, identifying and determining several solution strategies, identifying obstacles in solving problems, then finding the right solution to solve a problem that is being entered, and (5) Creativity and Creative Thinking, is the ability of students to unite everything in a new way, save something that is not observed by others, create something interesting that is not thought of by other people in general [12].

Inquiry model according to Wright J and Burrow L (2004), inquiry is a learning model that involves students actively through scientific activities, namely formulating problems, formulating hypotheses, conducting experiments, writing experimental results, analyzing data and drawing conclusions from the results of analysis [13]. The inquiry learning model is used as a solution because this model is a series of learning that emphasizes critical and analytical thinking processes to seek and find answers to a question in question [14]. Aris Shoimin (2014) states, the inquiry learning model is a model that can encourage students to be active in learning, inquiry learning is a learning activity where students are encouraged to learn through their own active involvement with concepts and principles, and teachers encourage students to have experiences and conduct experiments that allow students to discover principles for themselves. The inquiry learning model is a series of learning activities that emphasize the activeness of students to have a learning experience in finding material concepts based on the problems posed [15].

Advantage of the Inquiry Model stated Roestiyah (2012) mentions some of the advantages possessed by the inquiry learning model, namely that it can help students use existing memories to be associated with the concepts to be discussed, encourage students to think and work on their own initiative, give students freedom in learning, as well as encouraging students to be able to think and solve problems on the problems they are facing [16]. Edelson, Gordin, and Pea (1999) state that inquiry-based learning has three main advantages, namely providing opportunities for students to, (1) develop general inquiry abilities, (2) acquire specific investigative skills, and (3) develop an understanding of concepts. -scientific concepts [17].

Thinking Maps allows learners to feel more connected to the material, because it forces them to map their thought processes on paper, which leads to increased connections between content and experiences [18]. According to Alikhan, thinking maps are a visual tool with eight basic patterns of thought that help students' thinking processes to solve problems, according to Shahibudin Ishak, the visualization of the concept of the material being taught makes it easier for students to have a real picture of abstract material [19]. According to Hyerle & Williams (2010), Long & Carlson (2011) and Costa & Kallick (2000) Thinking maps invite students to express thoughts and ideas so that the teacher will see a graphical representation of the student's thinking. In contrast to other graphic organizers, thinking maps prioritize thinking strategies, focus on the process of finding the right answer, are a good control tool in mastering classroom learning materials, and are a learning strategy that is able to connect material more meaningfully [20].
3. Methods
The research design used in this study was a quasi-experimental method. Creswell explained that the quasi-experimental method is a method if each participant is not randomly assigned to several groups [21]. Meanwhile, the research design used was the Nonequivalent (Pretest-Posttest) Control-Group Design. The study consisted of a control group and an experimental group which was carried out in that group before being applied before being applied. Only in the special treatment group. Then the two groups were given a posttest to see the difference in the results of the control group and the experimental group.

The research instrument is a tool used by researchers in collecting data [22]. Instruments used in this research are: (1) test is a tool or procedure used to find out or measure something in an atmosphere, with predetermined ways and rules [23]. The test used in this study was a multiple choice test to obtain quantitative data on students' Higher Order Thinking Skills (HOTS). The test was given to students in the experimental class and control class before learning (pretest) and after learning (posttest). Testing was in the form of multiple choice to test Higher Order Thinking Skills (HOTS). The population in this study were students of class X MIPA SMA Al-Hasra with the research sample of class X MIPA 1 as the experimental class and class X MIPA 2 as the control class with 25 students in each class. The sampling technique used was purposive sampling technique with consideration of the similarity of the number of students in one class and the ability of students in the two classes which were not much different.

Types of Thinking Maps are Eight maps in Thinking Maps, consisting of Circles Map, Bubble Map, Double Bubble Map, Tree Map, Brace Map, Flow Map, Multi-Flow Map and Bridge Map. Each Map has its own thought process [11].

Thinking Maps has eight maps consisting of a Circles Map, Bubble Map, Double Bubble Map, Tree Map, Brace Map, Flow Map, Multi-Flow Map and Bridge Map. Each map has its own thought process. In this study, researchers used Tree Map and Brace Map types of Thinking Maps that are most suitable for chemicals.

The dependent variables (Higher Order Thinking Skills) in this study using Higher Order Thinking Skills Brookhart indicators. Brookhart (2010) states that the Higher Order Thinking Skills (HOTS)
The indicator consists of analyzing, creating, reasoning and logic, making decisions, creativity and creative thinking [12].

4. Result and Discussion

This study used a quasi-experimental study for the control class using the inquiry model, while the experimental class used an inquiry model assisted by thinking maps. Before the treatment was given a pretest consisting of 25 questions of Higher Order Thinking Skills (HOTS) in the control class and experimental class, and after the treatment was given a posttest with the same questions as many as 25 questions of Higher Order Thinking Skills (HOTS). The pretest was given to students in the control class and the experimental class at the beginning of the lesson before being given different treatments. This is done to determine the initial condition of students' Higher Order Thinking Skills (HOTS). Meanwhile, the posttest was given to determine the students' Higher Order Thinking Skills (HOTS) after being given different treatment in the control class and the experimental class. Data from the pretest and posttest results in the control and experimental classes can be seen in table 1 below.

| Data           | Pretest | Posttest |
|----------------|---------|----------|
| The Number of Students | 25      | 25       |
| The Highest Score  | 56      | 96       |
| The Lowest Score   | 12      | 60       |
| Average           | 33.28   | 81.28    |
| Median            | 36      | 84       |
| Standard Deviation| 13,649  | 9.217    |

From the data in Table 1, it can be seen that the pretest average value for the control class is 33.28 and the pretest average value for the experimental class is 30.56. The average posttest score for the control class is 81.28 and the posttest average score for the experimental class is 87.20. Overall, after being given different treatments between the control class and the experimental class, it can be seen that the difference in the posttest mean score of the experimental class is higher than the control class.

In the pretest data standard deviation for the control class obtained a value of 13.649 and for the experimental class obtained a standard deviation value of 13.705. This shows that the value of the control class has a data distribution that is close to the average value, while the value for the experimental class has a distribution of data that is further than the average value. In the posttest data, for the standard deviation value the control class obtained a value of 9.217, and for the standard deviation value the experimental class obtained a value of 8.246. This shows that the experimental class scores for the posttest data have a data distribution that is close to the average value, while the control class scores have a data distribution that is farther than the average value.

Data Pretest Results for Control and Experimental Class presented data from the pretest results regarding the analysis of the Higher Order Thinking Skills (HOTS) indicator for the control class and experimental class students in table 2. Based on Table 2, it shows that in the control class the highest indicator is the indicator of making decisions by 44% and the lowest is the indicator of reasoning and logic by 20%. In the experimental class the highest indicator was analyzing by 42% and the lowest indicator was reasoning and logic at 19%. In Table 4.2, it is also known that the pretest average results for the control class were 32% in the poor category, and in the experimental class by 28% for the poor category. The control class has a greater proportion of pretest in almost all indicators of Higher Order Thinking Skills (HOTS) than the proportion of pretest in the experimental class. This indicates that the
Higher Order Thinking Skills (HOTS) of students in the control class are better than the experimental class. Meanwhile, the pretest average results in the control class and the experimental class are still in the same category, which is low.

Table 2. Percentage of higher order thinking skills indicators in pretest students in control and experimental class (brookhart theory).

| No | Indicators HOTS      | Control Class (%) | Category | Experiment Class (%) | Category |
|----|----------------------|--------------------|----------|-----------------------|----------|
| 1. | Analysis             | 34                 | Low      | 38                    | Low      |
| 2. | Evaluation           | 46                 | Low      | 28                    | Low      |
| 3. | Creation             | 22                 | Low      | 24                    | Low      |
| 4. | Logic and Reasoning  | 20                 | Low      | 19                    | Low      |
| 5. | Judgment             | 44                 | Low      | 35                    | Low      |
| 6. | Problem Solving      | 32                 | Low      | 26                    | Low      |
| 7. | Creative Thinking    | 26                 | Low      | 26                    | Low      |
|    | **Average**          | **32**             | **Low**  | **28**                | **Low**  |

Data Postest Results for Control and Experimental Class The data on the posttest results regarding the analysis of the Higher Order Thinking Skills (HOTS) indicator for the control class and experimental class students are presented in table 3 as below.

Table 3. Percentage of HOTS indicators in postest students in control and experimental class (brookhart theory).

| No | Indicators HOTS      | Control Class (%) | Category | Experiment Class (%) | Category |
|----|----------------------|--------------------|----------|-----------------------|----------|
| 1. | Analysis             | 84                 | Very Good| 88                    | Very Good|
| 2. | Evaluation           | 80                 | Very Good| 88                    | Very Good|
| 3. | Creation             | 80                 | Very Good| 84                    | Very Good|
| 4. | Logic and Reasoning  | 77                 | Good     | 83                    | Very Good|
| 5. | Judgment             | 83                 | Very Good| 88                    | Very Good|
| 6. | Problem Solving      | 68                 | Good     | 84                    | Very Good|
| 7. | Creative Thinking    | 78                 | Good     | 94                    | Very Good|
|    | **Average**          | **78**             | **Good** | **87**                | **Very Good** |

Based on table 3 indicates that the Higher Order Thinking Skills (HOTS) of students in the experimental class are better than the control class. For the posttest average results in the control class it is in the good category, while the experimental class is in the very good category.

The sample prerequisite test was carried out after obtaining the pretest data results from the control class and the experimental class. The prerequisite test aims to determine the feasibility of a sample. The prerequisite tests that were carried out included the normality test and the homogeneity test, both of which were carried out using the help of SPSS version 22 software.

Data analysis sample prerequisite test was carried out after obtaining the pretest data results from the control class and the experimental class. The prerequisite test aims to determine the feasibility of a sample. The prerequisite tests that were carried out included the normality test and the homogeneity test, both of which were carried out using the help of SPSS version 22 software.
Sample normality test aims to determine whether a pretest data is normally distributed or not. The normality test conducted in this study used the Kolmogorov-Smirnov test. A data is said to be normally distributed if \( \text{Sig} > \alpha \) with a significant level (\( \alpha \)) of 0.05. Results of the normality test of the pretest Higher Order Thinking Skills (HOTS) of students in the control class show a significant value of 0.125 and in the experimental class of 0.082. It can be seen that the pretest significance value of both the control class and the experimental class is greater than the significant level \( \alpha = 0.05 \). Based on this, it can be concluded that the pretest data tested in the control and experimental classes were normally distributed.

Sample homogeneity test based on the results of the normality test, the pretest data obtained in both the control class and the experimental class were stated to be normally distributed. For the next step, the homogeneity test was carried out for the pretest data using the Levene test, which aims to determine the similarities of the two research classes. Both classes are declared homogeneous if \( \text{Sig.} \) or \( p \)-value > 0.05. Homogeneity test results pretest data homogeneity test of students in the Higher Order Thinking Skills (HOTS) in the control and experimental classes were 0.890. It can be seen that the pretest significant value of the control class and experimental class is greater than the significant level \( \alpha = 0.05 \). Based on this, it can be denied that the pretest data tested from the two variants are the same or homogen.

Independent Sample T Test after carrying out the normality test and the pretest data homogeneity test, it was found that the pretest data were normally distributed and had the same variants or were homogeneous. The next step is to do the Independent Sample T Test using the help of SPSS version 22 software. The test criteria for the Independent Sample T Test are if the \( p \)-value (\( \text{Sig.} \) 2-tailed) \( \leq 0.05 \) then \( H_0 \) is rejected and \( H_1 \) is accepted. The results of the Independent Sample T Test pretest data in the control and experimental classes can be seen in Table 4 as follows:

| Statistics | \( N \) | \( \alpha \) | Sig. (2-tailed) | \( t \text{count} \) | \( t \text{table} (\alpha = 0.05) \) | \( \text{Df} \) | Conclusion |
|------------|--------|--------|-----------------|------------------|---------------------------|--------|-----------|
|            | 25     | 0.05   | 0.485           | 0.703            | 2.010                     | 48     |            |
| \( N \)    |        |        |                 |                  |                           |        | Sig. (2-tailed) > \( \alpha \) |
| \( \alpha \)|        |        |                 |                  |                           |        | \( H_0 \) is accepted, there is no difference |
| Sig (2-tailed)|        |        |                 |                  |                           |        | the average pretest value |
|            |        |        |                 |                  |                           |        | between the control class and |
|            |        |        |                 |                  |                           |        | the experiment class |
| \( t \text{count} \)|        |        |                 |                  |                           |        | \( t \text{count} < t \text{table} \) (there is no difference |
| \( t \text{table} (\alpha = 0.05) \)|        |        |                 |                  |                           |        | the average pretest value |
|            |        |        |                 |                  |                           |        | between the control class and |
|            |        |        |                 |                  |                           |        | the experimental class |

Based on the data in Table 4, the results of the pretest hypothesis test for the control and experimental classes obtained a sig (2-tailed) value of 0.485 and a value of \( \alpha = 0.05 \). This shows that the sig (2-tailed) value > \( \alpha \), so that \( H_0 \) is accepted and \( H_1 \) is rejected. The \( t \text{count} \) value of 0.703 is smaller than the \( t \text{table} \) value of 2.010. So it can be concluded that there is no difference in the average Higher Order Thinking Skills (HOTS) of students between the control class and the experimental class before being given treatment. Therefore, both classes are suitable as research samples.

Data analysis prerequisite, in this analysis prerequisite test, the data used were students' posttest data in the control class, namely the class that only used the inquiry method without using thinking
maps and the posttest data for students in the experimental class, namely the class using the inquiry method assisted by thinking maps. Data analysis normality test, the data from the calculation of the posttest normality test for the control and experimental classes are presented in table 7 below:

| Statistics | Control | Experiment | Conclusion               |
|------------|---------|------------|--------------------------|
| N          | 25      | 25         | Sig > α (normally        |
| α          | 0,05    | 0,05       | distributed data)        |
| Sig.       | 0,078   | 0,099      |                          |

In table 5, it can be seen that the results of the normality test of the Posttest Higher Order Thinking Skills (HOTS) of students in the control class show a significant value of 0.078 and in the experimental class of 0.099. It can be seen that the posttest significant value of both the control class and the experimental class is greater than the significant level α = 0.05, so that H₀ is accepted. Based on this, it can be concluded that the posttest data tested in the control and experimental classes are normally distributed.

Data Analysis Homogeneity Test

The data from the calculation of the posttest homogeneity test for the control and experimental classes are presented in table 8 below:

| Statistics | Control | Experiment | Conclusion               |
|------------|---------|------------|--------------------------|
| α          | 0,05    |            | Sig > α                  |
| Sig.       | 0,825   |            | (Data homogen)           |

In table 6, it can be seen that the results of the posttest homogeneity test for students' Higher Order Thinking Skills (HOTS) in the control and experimental classes were 0.825. It can be seen that the significant value of the posttest control class and the experimental class is greater than the significant level α = 0.05, so that H₀ is accepted. Based on this, it can be concluded that the posttest data tested from the two variants are the same or homogeneous.

Hypothesis Test

After carrying out the normality test and homogeneity test on the posttest data for the control class and experimental class, it is known that the data is normally distributed and has the same variants or is homogeneous. The next step is to test the hypothesis, because the normality test is normally distributed and the homogeneity test is homogeneous, so to test the hypothesis in this study using the Independent Sample T Test using SPSS software version 22. In testing the hypothesis it is said to have a significant difference if the Sig. (2-tailed) <α and there is no significant difference between the 2 groups being studied if Sig. (2-tailed) >α, with a significant level (α) = 0.05. The results of the posttest data hypothesis test for the control and experimental classes can be seen in table 9 as follows:

| Statistics | Independent Sample T Test | Conclusion               |
|------------|---------------------------|--------------------------|
| N          | 25                        | Sig. (2-tailed) <α       |
| α          | 0,05                      | H₀ is rejected, so there is a difference |
| Sig.       | 0,021                     | the average posttest score between the control class and the experimental class |
Based on the data in Table 7, the results of the posttest hypothesis test in the control and experimental classes obtained a sig (2-tailed) of 0.021 and a value of \( \alpha = 0.05 \). This shows that the sig (2-tailed) value < \( \alpha \), so that \( H_0 \) is rejected and \( H_1 \) is accepted. For \( t_{count} \), it was obtained a value of 2.393, greater than the \( t_{table} \) value of 2.010. It can be concluded that there is a difference in the average posttest score between the control class and the experimental class. The difference in the average posttest results indicates that there is an influence of the inquiry model assisted by thinking maps on students’ Higher Order Thinking Skills (HOTS) on chemistry.

Purpose of this research is to find out whether there are implications of the thinking maps assisted inquiry model for higher order thinking skills. Brookhart classifies Higher Order Thinking Skills (HOTS) into 7 indicators, including:

- Analyzing indicator is an indicator that assesses the quality of students’ thinking when breaking down information and making sense with that information[12]. The results of the achievement of the indicators of analyzing the experimental class students obtained a higher percentage than the control class although the difference was not too far apart. This is because in the inquiry-thinking maps based learning step there is an observation stage where students are asked to analyze the thinking maps provided by the teacher and relate them to phenomena. Meanwhile, control class students have a stage of processing and analyzing information after the stage of gathering information without the help of thinking maps. The results of research conducted Long (2011) show that thinking maps teach students to think critically[18]. According to Duron (2006) critical thinking can be interpreted as an ability to analyze and evaluate information[24].

- Evaluating indicator is an indicator that can assess the ability of students to evaluate material and methods based on the intended objectives [12]. Experiment class students get a higher percentage than the control class. This is because the experimental class uses the help of Student Worksheets (LKPD) thinking maps. In accordance with the results of research conducted Long (2011), it shows that thinking maps teach students to think critically[18]. Critical thinking can be defined as an ability to analyze and evaluate information [24].

- Creating indicators are indicators that can assess students’ ability to group things together in a new way, or build something that already exists into something new[12]. Experiment class students get a higher percentage than the control class. This is because the experimental class uses the help of Student Worksheets (LKPD) thinking maps. On the thinking maps Student Worksheet (LKPD), students are trained to make thinking maps according to their respective creativity. This can train the ability to create and creativity of students. As explained by Hassan (2016) that the purpose of introducing thinking maps is to produce human resources who have critical, creative, innovative and competitive thinking in the future [11]. In addition, inquiry learning trains students to dare to express opinions and discuss with group members in finding, investigating, and creating different ways of solving problems or assignments given by the teacher so that problems can be solved easily [25].

- Reasoning and logic are indicators that can assess students’ ability to make or evaluate deductive conclusions or make or evaluate inductive conclusions [12]. The experimental class got a higher percentage than the control class. This is because the experimental class uses the help of Student Worksheets (LKPD) thinking maps. Similar to research conducted by Kostelnikova & Ozvoldova (2013) that the learning stages using inquiry learning models can help students have higher order thinking skills (HOTS) where students will use logic, think creatively and build knowledge students who ultimately motivate students in the learning process [26]. Meanwhile, according to Varela P and Costa M F (2015) inquiry-based learning can achieve a higher level of understanding and development of better reasoning skills and development of scientific process skills [27].
students. Types of decision making include evaluating the credibility of a source, identifying the assumptions implied in the information, and identifying rhetorical and persuasive methods [12].

Experiment class students get a higher percentage than the control class. This is because the experimental class uses the help of student worksheets (LKPD) thinking maps. Research Armawan & Yuliati (2017) shows the same results, namely the thinking maps strategy through guided inquiry learning can improve students' critical thinking skills [28]. According to the opinion Ennis (2011) critical thinking ability is the ability to think logically which is focused on making decisions about what to believe and what to do [29]. Redhana (2010) also argues that critical thinking skills are skills in making a decision that can be trusted and can be justified [30].

Problem solving are indicators that can assess students' ability to solve problems that involve the content or concepts being taught [12]. The experimental class gets a higher percentage than the control class. This is because the experimental class uses the help of student worksheets (LKPD) thinking maps. According to Winfield (2012) Thinking Maps often help promote reading comprehension, the writing process, problem solving, and thinking skills [31]. Thinking Maps can also encourage strategic thinking to help students see which thinking skills are suitable for use in solving problems [32]. Based on research conducted by Datur (2017) learning with the help of thinking maps can improve students' problem-solving abilities in solving problems indicated by cognitive changes of students who are getting better and an increase in the number of students who answer posttest questions correctly [33].

Creative thinking are indicators that can assess the ability of students to produce new ideas or new products, or the ability of students to rearrange existing ideas in a new way or connect two different content or text fields [12]. The experimental class gets a higher percentage than the control class. This is because the experimental class uses the Student Worksheet (LKPD) thinking maps. As explained by Susantini (2016) that LKS or LKPD can develop creative thinking skills [34]. The same thing was also explained by Hassan (2016) that the purpose of introducing thinking maps is to produce human resources who have critical, creative, innovative and competitive thinking in the future [11]. The same explanation was also conveyed by Savich (2009), one of the most important aspects of thinking maps is the ability of students to display critical thinking skills, creative thinking, and independent thinking to complete their maps [33].

Limitation of this research is is that it only uses the tree map and brace map types of thinking maps. This is because the thinking maps type tree map and brace map are most suitable for the material used. The scope of the study, it is recommended to conduct the same research on another types of thinking maps, it is recommended for further researchers to conduct research on various types of mind maps, including circle maps, double bubble maps, flow maps, multi-flow maps, and bridge maps.

5. Conclusion

The results showed that the inquiry learning model assisted with thought maps has implications for Higher Order Thinking Skills (HOTS) on chemistry. This is based on the results of the posttest data hypothesis test using the independent sample t-test, the value of sig <α is 0.021 <0.05 at the 5% significance level so that H₀ is rejected and H₁ is accepted. Overall, the achievement of the Higher Order Thinking Skills (HOTS) indicator for the experimental class students for each indicator obtained a higher value than the control class. Based on the posttest results, it shows that the percentage of the average value of the Higher Order Thinking Skills (HOTS) indicator of the experimental class students is 87% in the very good category. This shows that the application of the Inquiry learning model assisted by Thinking Maps has an effect on students' Higher Order Thinking Skills (HOTS) on the chemistry material periodic characteristics of the elements.

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