# THE EFFECTIVENESS OF MALCOLM'S MODELING BASED ON KWL THINKING STRATEGY TOWARDS THE PROBLEM SOLVING SKILLS AT 7TH GRADE JHS OF TAINAN MUNICIPAL JINCHENG

A Final Project

submitted in partial fulfillment of the requirements for the

degree of *Sarjana Pendidikan*

Mathematics Education Study Program

by

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# STATEMENT OF ORIGINALITY

I, Arno Johan, hereby declare that this submission is my own work and has not been submitted in any form for another degree or diploma at any university or other institute of tertiary education, Information derived from the published and unpublished work of others has been acknowledged in the text and a list of references is given in the references.

Semarang, June 2017

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# APPROVAL

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The Effectiveness of Malcolm's Modeling Based on KWL Thinking Strategy Towards the Problem Solving Skills at 7th Grade JHS of Tainan Municipal Jincheng

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# MOTTO AND DEDICATION

## MOTTO

Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning. (Albert Einstein)

A wise man first thinks and then speaks and a fool speaks first and then thinks. (Ali ibn Abi Talib)



## DEDICATION

This final project is dedicated to :

My beloved parents, Alm. Tarnoto and Sri Harwati

My brothers, M. Nur Hidayatsyah and M. Nur Arifiansyah

All my friends in Mathematics Department

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Finally, the researcher hopes this final project will be beneficial and useful for all the reader who interested in this topic.

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# ABSTRACT

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**Keywords** : *Malcolm's Modeling, KWL Thinking Strategy, Problem Solving Skills.*

Problem solving skills in mathematics is the essential thing for the students to apply that skill in real life. The learning model that can be implemented to improve problem solving skills is Malcolm's Modeling.

The objectives of this research were : (1) to measure problem solving skill of the students who was taught by Malcom's modeling based on KWL thinking strategy towards the mastery learning; (2) to compare the students on problem solving skills who received Malcom's Modeling based on KWL Thinking Strategy and expository learning model in the chapter of Scientific Notation. The population of this research were students of seventh grade of Tainan Municipal Jincheng Junior High School in the academic year of 2016/2017. By simple random sampling technique, 705 class was selected as the experiment class and 711 as the control class. The data were collected by using some instruments, they were test and documentation. Data analysis used SPSS software and excel for t-test and proportion test.

The results of the research showed that : (1) Malcolm's Modeling based on KWL Thinking Strategy gained good result to the score of the students. It was seen from the proportion test that 86% of the students in experiment class were passing mastery learning clasically (2) the problem solving skill of the students who received Malcom's Modeling using KWL Thinking Strategy was better than that skill of the students who received expository learning model.

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# CHAPTER I
# INTRODUCTION

## 1.1 Background of the Research

Education is one of the rights for all the citizen. Every person needs education to increase their social life. By using education, the people can get a job and have prosperous life.

Knowledge can be obtained in many institutions. The institution can be obtained online by using internet or offline which can be obtained in formal school. Nowadays, education can be developed based on its situation and condition.

In formal education, studying indicates the changes into positive stage so that can be obtained the skills, expertise and new knowledge. The results of the learning process are reflected in academic achievement. However, to get the best achievement needs maximum effort in a learning process. The learning process that occurs in individuals is an important thing, because by studying individuals know their environment and adapt to the surrounding environment. According to Irwanto (1997:105) learning is a process of change and occur within a specified period.

One of the challenges to this century is to get good human resources. Good human resources are the human that can work in the under-pressure situation. In under-pressure situation, people must have the skills that can solve the problem properly. Because of that, skill of problem solving is indispensable. According to Wismath et al (2014), problem solving is a critical component of a comprehensive

21st century education, investigates the perceptions of the students of taking a university liberal education course designed to develop problem solving skills.

Mathematics is one of the subject which is available in every school all over the world. Mathematics is considered by students as a difficult subject by many students. According to an investigation by the Ministry of Education's Department in Taiwan, 154,426 students in 866 elementary and junior high schools, it was concluded that mathematics is the most disliked subject among elementary, junior high and senior high school students. This data also based on the results of international research named PISA or Program for International Student Assessment.

PISA is a program of cooperation in several countries belonging to the OECD (Organization for Economic Co-operation and Development) to compare the academic skills of students aged 15 years in various countries in the fields of mathematics, science, and reading. Research is done by testing (assessment) academic skills of students aged 15-16 years in the form of a written exam every 3 years for categories of subjects of mathematics, science, and reading. Recent research conducted in 2015 to include 510,000 students from 65 countries, including Indonesia as shown in the figure below. Meanwhile, Taiwan occupies a large position 5. Given this research, the researchers expected to find out how the problem solving skills of students in Taiwan and develop that learning model in Indonesia.

The PISA 2015 survey focused on science, with reading, mathematics and collaborative problem solving as minor areas of assessment. PISA 2015 also

included an assessment of young people's financial literacy, which was optional for countries and economies.

Based on PISA result on 2015, more than one in four students in Beijing-Shanghai-Jiangsu-Guangdong (China), Hong Kong (China), Singapore and Taiwan are top-performing students in mathematics, meaning that they could handle tasks that require the ability to formulate complex situations mathematically, using symbolic representations. It could be concluded that Taiwan's student in solve mathematical problem is excellent. This data can be seen in table 1.1 below.

Table 1.1 PISA's Score 2015

| **Country** | **Mathematics Mean Score in PISA 2015** |
|---|---|
| Singapore | 564 |
| Hongkong | 548 |
| Taiwan | 542 |
| B-S-J-G China | 531 |

(Source : *PISA 2015; OECD*)

There are many things which cause the students can not do the problems associated with reasoning, one of which is the lack of problem solving skills in students. Mathematical problem solving skills can be seen through: (1) understand the problem, students can identify the elements that are known, were asked, and the adequacy of the required elements, (2) plan the problems, students can formulate a mathematical problem or to develop a mathematical model. The students can implement strategies to solve various problems. (3) solve the problem, students are expected to perform well to complete the planning, (4) review and make conclusions.

Malcolm's modeling method in its implementation involves the students independently in all stages of learning and requires a long time because of all the activities carried out in groups in school (Wells et al, 1995:24). Therefore, Malcolm's modeling methods can be modified into a learning model with procedural steps and systematically adapted to the characteristics of students who are not familiar implementing learning constructivism and the allocation of time available at school (Syarifah, 2015: 239).

Malcom's modeling as a learning model was developed based on learning theory of Jean Piaget, theory of Vygotsky and theory of David Ausubel. Syntax Malcom's Modeling can guide students who are not familiar implementing learning constructivism.

Solving the problem for mathematics problem is not easy. It needs an understanding of the question, because in mathematical problem the students have to analyze what is meaning of the problem. Many students can not interpret what is the meaning of the question.

Barton (2002) wrote that, in addition to connecting understanding assignments to students' real-world experiences, teachers need to show students that becoming effective consumers of mathematics text has value. Students need to see firsthand that practicing the right reading strategies will improve their achievement.

One of the method to understand and analyze the question is by using K-W-L strategy. In reading, the K-W-L strategy helps all students, no matter the age or

achievement level, activate their prior knowledge, develop a purpose for the reading, and make connections between new information and familiar ideas.

The K-W-L strategy (what we know, what we want to know, what we learned) is a strategy to make the student list what they already know about a topic, to write what they would like to know about a topic, and to write what they learned and would still like to learn.

Teachers adapted and modified the K-W-L strategy to maximize its effectiveness with their students who, in turn, became more active learners and higher achievers. Using K-W-L strategy, the student will do better in understanding the question of the problem. In this strategy the students make an outline of the question in order to simplify the problem in simple way. If the students can understand the question properly, they will easily finish their mathematical problems.

From the description, the researcher will conduct a research of "The Effectiveness of Malcoms Modeling Based on KWL Thinking Strategy Towards The Problem Solving Skills at 7th Grade JHS of Tainan Municipal Jincheng".



## 1.2 Statements of The Problem

Based on the background of the research and the reasons for choosing the topic, the aim at this research is to answer the following questions:

1. Is problem solving skill of the students who was taught by Malcolm's modeling based on KWL thinking strategy reaching the mastery learning?

2. Is the problem solving skill of the students who received Malcolm's Modeling using KWL Thinking Strategy better than that skill of the students who received expository learning model?

## 1.3 Objectives of The Research

In this research, the researcher has three purposes to be achieved as follows.

1) To measure problem solving skill of the students who is taught by Malcom's modeling based on KWL thinking strategy towards the mastery learning.
2) To compare the students on problem solving skill who received Malcom's Modeling based on KWL Thinking Strategy and expository learning model in the chapter of scientific notation.

## 1.4 Significances of The Research

The research is expected to be able to give some advantages for teacher, students and other researchers. The significance of this research is as follows.

1) For the teachers

   This research is expected to be used as a consideration for the teachers to choose the media or technique to teach and improve problem solving skills of the students. It seems simple to choose the techniques or medium to teach students, but in practical, they give a big deal for the success of teaching learning process in a classroom.

2) For the students

This research is expected to increase the students‘ knowledge, interest and scores in learning Mathematics. Hopefully, the students can improve their problem solving skills based on KWL thinking strategy. This research will build students‘ reasoning in mathematics problems.

3) For other researchers

This research is expected to be a useful additional information to enrich the reference related to the improving the students‘ problem solving skills based on KWL Thinking Strategy. They are able to combine other topics with another methods and techniques.

## 1.5 Operational Definition of Terms

In order to give better understanding of this research, the definition of terms explains below.

### 1.5.1 Effectiveness

The learning in this research is effective if :

1. The mean of problem solving skills of the students who received Malcom's modeling based on KWL thinking strategy reach the mastery learning on chapter Scientific Notation, that is 65 for mastery learning individually and mastery learning classically reach 75% from the number of the students.
2. The problem solving skill of the students who received Malcom's Modeling using KWL Thinking Strategy is better than that skill of the students who received expository learning model.

### 1.5.2 Malcolm's Modeling

Malcolm's Modeling Method consists of five main stages, those are orientation stage, construction stage, discovery discussion stage, application stage, and application discussion stage. In model development stage, the students use scientific method to construct a hypothesis, do experiment, analyze data and make conclusion. In model deployment the students apply the model to solve the problem.

### 1.5.3 KWL Thinking Strategy

The K-W-L strategy (what we know, what we want to know, what we learned) is a strategy to make the student list what they already know about a topic, to write what they would like to know about a topic, and to write what they learned and would still like to learn. (Shelley et al, 1997).

In using K-W-L strategy, there is developing strategy that is K-N-W-S. In this case K-N-W-S can be defined as What I Know, What I Want to Learn, What I Learned (K-W-L) (Ogle, 1986) is an active reading tool to help students build content knowledge by focusing on the topic and setting the purpose for the upcoming reading. During K-W-L, students list what they know (K) about a topic, questions they have and what they want to learn (W), and summarize what they learned (L). In a similar pattern, K-N-W-S allows students to use word problems to answer what facts they know (K); what information is not relevant (N); what the problem wants them to find out (W); and what strategy can be used to solve the problem (S).

### 1.5.4 Problem Solving Skills

Problem solving in mathematics often is viewed with a conceptual model proposed by George Polya (1957). Polya's model has four steps: (1) understand the problem (2) devise a plan (3) carry out the plan (4) look back (and forward).

### 1.5.5 Scientific Notation

The material of scientific notation is one the chapter in seventh grade in Junior High School on the first semester in Taiwan. In this chapter, the students are being able to change the number into scientific notation and make operation in scientific notation, such as multiplying and dividing.

## 1.6 Outline of The Research

This research is divided into three parts. They are early part, main part, and final part. Early part contains title page, acknowledgement, abstract, table of content, list of figure, list of table, and list of appendices.

Main part contains five chapters as follows. On the first chapter, it contains background of the research, statements of the problem, objectives of the research, significance of the research, definition of terms, and outline of the research. The second chapter contains the theories that researcher used as literature review in arranging the research, relevant research, thinking framework, and hypothesis. The third chapter contains the research method, research design, method of collecting data, research procedure, and analyze research instrument. The fourth chapter contains the research result and the discussion. Meanwhile, the last chapter

contains the conclusions and suggestions from the researcher. In addition, the final part contains of references and appendices on the research.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Theoritical Review

### 2.1.1 Mathematics Problem Solving Skills

Problem solving is what a student does when he or she is given a task and not told how to approach it (Laterell, 2010). Problem solving can be defined as the process of finding solutions to difficult or complex issues. Problem solving is one of ten standards occurring across all grade levels in the Principles and Standards. Problem solving is an integral part of all mathematics learning, and so it should not be isolated from mathematics program (NCTM, 2000). According to Erson (2016) Focusing on problem solving in lessons develops the students' high level thinking. For this reason, students perform self-learning in mathematics lessons with problem solving process. Problem solving plays an important role in mathematics education and most of learning is an occour as a result of problem solving process. Problem solving skills are the skills required to solve problems as a member of a group are essential for successful employment, where the individual is often a member of a team of diverse specialists working in separate locations (ACER, 2010).

Polya (1945) describes the process of problem solving at four stages, including understanding the problem, determining the strategy, implementing the selected strategy and assessment. At the stage of understanding the problem, the student is expected to state what he understood from the problem and to determine what are the given and unknown in the problem and also to suggest clearly the

condition of the problem. At the stage of determining the strategy, the student is expected to determine which steps such as calculation, drawing, etc. to follow in order to reach the requested. The teacher, in this process, can promote the use of different problem solving strategies by writing the all strategies on the board and can enable the student to choose the suitable strategy (Miller, 2000). The following stage includes the application of selected strategy by the student. At the stage of application the selected strategy, the solution should be checked step by step. At the stage of assessment, on the other hand, the student should control whether the solution he made is right and meaningful. During the process of control, it must be fully put forth what has been done and where it has been done (Erson: 2016).

Problem solving in mathematics often is viewed with a conceptual model proposed by George Polya (1957). Polya's model has four steps.

1) Understand the problem.

Determine what information is given, what is the unknown, what information is needed or not needed, and the context or conditions of the problem. Restate the problem to make sure terminology and facts are understood.

2) Devise a plan.



Consider how to go about solving the problem and what strategies would help in finding a solution. This may be as simple as selecting the numbers and operations demanded by the problem. It might include examining different ways to approach the problem; for example, comparing it to problems solved previously, or finding related problems, or making and checking predictions.

3) Carry out the plan.

Use the plan as devised and check or prove that each action taken is correct.

4) Look back (and forward).

Examine the result or solution to make sure it is reasonable and solves the problem. Ask if there could be other solutions or if there are other ways to get a solution. Perhaps extend or generalize the problem.

The indicator of problem solving skills of students in this research are as follows.

1) Students are able to understand the problem. In step understand the problem, students can write down the things that are known or asked on the matter.
2) Students are able to make the planning of problem solving. On the steps to make this planning learners can make the analogy or sketch of the matter, and to write the formula to work question.
3) Learners are able to perform troubleshooting plan. In carrying out the planning step, after determining how to do the problems, students solve problems in a way that has been determined.
4) Learners are able to look back on a solution. In this step the student retest answers have been obtained then make conclusions.

Based on indicator, the problem solving skills for chapter scientific notation can be described like in the following example.

If the average human breathes 15 times per minute, what is the approximate number of breathes that *you* have take in your lifetime? What about Luo Meizhen, the oldest woman on Earth, who lived for 127 years?

Solution of the problem based on Polya can be seen in the following table 2.1 :

Table 2.1 Example of Polya's Problem Solving Skills Step

| No. | Steps | Solution |
|---|---|---|
| 1 | Understand the problem: | Given : Average human breathes=15 times/minute<br>Luo Meizhen =127 years<br>Question : Approximate number of breathes of Luo Meizhen |
| 2 | Devise a plan | 1 day= 24 hours<br>1 hour= 60 minutes<br>1 day = 24 x 60= 1440 minutes<br>1 year= 365 day<br>1 year= 365 x 1440=525,600 |
| 3 | Carry out the plan | Approximate number of breathes of Luo Meizhen = $525{,}600 \times 127$<br>$= 66{,}751{,}200$<br>$= 6.67512 \times 10^7$ |
| 4 | Look back and forward | Thus, the approximate number of breathes of Luo Meizhen is $6.67512 \times 10^7$ times/minute |

### 2.1.2 Malcolm's Modeling

Malcolm's modeling method in its implementation involves the students independently in all stages of learning and requires a long time because of all the activities carried out in groups in school (Wells et al, 1995: 24). Therefore, Malcolm's modeling methods can be modified into a learning model procedural steps and systematically adapted to the characteristics of students who are not familiar implementing learning constructivism and the allocation of time available at school. (Syarifah, 2015:239)

Malcom's modeling as a learning model was developed based on learning theory learning theory of Jean Piaget, Vygotsky learning theory and the theory of David Ausubel meaningful learning. Syntax Malcom's Modeling become more guided intended for students who are not familiar implementing learning constructivism.

### 2.1.3 KWL Thinking Strategy

The K-W-L strategy (what we know, what we want to know, what we learned) is a strategy to make the student list what they already know about a topic, to write what they would like to know about a topic, and to write what they learned and would still like to learn. (Shelley et al, 1997).

Teachers adapted and modified the K-W-L strategy to maximize its effectiveness with their students who, in turn, became more active learners and higher achievers.

In using K-W-L strategy, there is developing strategy that is K-N-W-S. In this case K-N-W-S can be defined as What I Know, What I Want to Learn, What I Learned (K-W-L) (Ogle, 1986) is an active reading tool to help students build content knowledge by focusing on the topic and setting the purpose for the upcoming reading. During K-W-L, students list what they know (K) about a topic, questions they have and what they want to learn (W), and summarize what they learned (L). In a similar pattern, K-N-W-S allows students to use word problems to answer what facts they know (K); what information is not relevant (N); what the problem wants them to find out (W); and what strategy can be used to solve the problem (S).

In column of What I WANT to Know or W column, the students had to wrote about what they want to know. The teacher did not give any instructions, the teacher wanted the students to find by themselves about what they want to know. As students take time to think about what they already know about the topic and the general categories of information that should be anticipated, questions emerge. Not all students agree on the same pieces of information, some information is conflicting, some of the categories have had no particular information provided. All this prereading activity develops the students' own reasons for reading, reading to find answer to questions that will increase their reservoir of knowledge in this topic (Ogle, 1986). The teacher's role in this stage is central. The teacher highlight their disagreements and information and help the students raise questions that focus their attention and energize their reading. The majority of W column is done as a group activity, but before students begin to analyze, each student writes down on his/her own worksheet for the specific questions that he/she is most interested in having answered as a result of the discussion.

In column of What I LEARNED or L column, the students summarize what they learned. The students can write the answers from their questions in W column into L column. In reading, the KWL strategy helps all students, activate their prior knowledge, develop a purpose for the reading, and make connection between new information and familiar ideas. KWL is good for the students when the teacher had explained about the material.

The development method of KWL Thinking Stategy is KNWS. In similar pattern, KNWS allow students to use word problem to answer what facts they know

(K); what information is not relevant (N); what the problem wants them to find out (W); and what strategy can be used to solve the problem (S) (RMC Research Corporation, 2005). This method is good for the students in solving the mathematics problem. It can improve the problem solving skills of the students because in this method, allows students to plan, organize, and analyze how to solve word problems, while teachers can evaluate students' understanding and possible misconseptions about mathematics problem (RMC Research Corporation, 2005).

### 2.1.4 Malcolm's Modeling Based on KWL Thinking Strategy

Malcolm's Modeling Based on KWL Thinking Strategy can help students in understanding the contextual problems so that it can help students in solving problems. In addition to the Malcolm's Modeling based on KWL Thinking Strategy, students are required to be able to understand the problems by themselves and the teacher only acts as a facilitator so that it can help students in the process of solving problems and can train problem-solving skills through problems in the worksheet. Students are also accustomed to problem-solving activities through formative/quiz tests given by the researcher at the end of the lesson and through homework assignments. At the time of the group discussion the students looked so enthusiastic in asking and doing. In addition, discussions conducted by students provide opportunities for students to interact, exchange ideas, and help each other in solving problems. At the end of the discussion one of the students confidently dared to explain the results of their group answers in front of the class and the other students responded to the student's exposure.

### 2.1.5 Learning

Learning is the act of acquiring new, or modifying and reinforcing, existing knowledge, behaviors, skills, values, or preferences and may involve synthesizing different types of information (McManus, 2001). The ability to learn is possessed by humans, animals, plants and some machines.

The depth or nature of the changes involved are likely to be different. Some years ago Säljö (1979) carried out a simple, but very useful piece of research. He asked a number of adult students what they understood by learning. Their responses fell into five main categories:

a. Learning as a quantitative increase in knowledge. Learning is acquiring information or 'knowing a lot'.
b. Learning as memorising. Learning is storing information that can be reproduced.
c. Learning as acquiring facts, skills, and methods that can be retained and used as necessary.
d. Learning as making sense or abstracting meaning. Learning involves relating parts of the subject matter to each other and to the real world.
e. Learning as interpreting and understanding reality in a different way. Learning involves comprehending the world by reinterpreting knowledge (quoted in Ramsden 1992: 26).

### 2.1.6 Learning Theories

#### *2.1.6.1 Jean Piaget's Theory*

Learning is an agent necessity process for man; man is born on this earth weak, incapable and helpless (McManus, 2001). Through learning, man can be graded until he becomes able to face life's problems and his inability turns to innovate impossible things. Any stage of human growth depends on the learning and the more he is growth, his knowledge and his mind expands and becomes more able to think and innovate. There is no doubt that the process of learning in its humanitarian concept is a continuous process that begins at birth and end with the individual dead and are subject to the school of life, so it is the process of adaptation and building beginning a few and simple even to become a towering building. Therefore, learning and its strategies was and will always be the base of thinkers and scientists research.

There are some factors affecting the cognitive construction. The cognitive construction is not just adding information to the stock of learner cognitive. Piaget believes that thought processes are slowly changing from birth to maturity, but get to the combined group of factors are:

1) Inheritance

Piaget acknowledges in every upgrade and intellectual life of the importance of inheritance and he believes that inheritance affect cognitive construct from two sides which are construct nerve. The inherited nerve construct as Piaget believed may be somewhat impede intellectual function or may facilitated it, but cannot itself be the cause of the same intellectual function. The second is functional constants.

Functional constants are processes of the organization and an adaptation of the general characteristics of intelligent activity or use functional properties, the person may use assimilation more than harmonization or vice versa or he uses them by the same percentage and the contrast between the relative amounts of representing and functional harmonization formula, and this formula remains constant over the life of the individual as each individual has unique functional formula must genetically.

2) Content Function Construction

Piaget believes that intelligence consists of three components: Content: means behavioral patterns, observation and perceived kinetic that reflect intellectual activity, the intelligence's content is different for some reason according to nature of the content from time to time and from one child to another. It thus refers to the qualitative behavior of the child and that float on the surface such as the responses given by the child of the problems and the different positions like in the ability to change the trial from early childhood to late childhood, ethical behavior and wisdom, understanding the child to the outside world, and understand natural phenomena. Function: indicates the characteristics of intellectual activity, which is a representation and harmonization which continuing throughout the intellectual upgrade, means the processes that are resorted to by the individual when he interaction with environmental stimuli the changes of quality construct in cognitive function are clearly changes in intellectual function, which is generally defined as intelligent, which way that made the child through intelligently progress. Constructions indicate extracted educational characteristics; they are plans (knowledge and information) that explain the emergence of special behavioral

techniques. A wider meaning the case of thinking at an individual in some stage of development.

1) Activity

The cognitive growth of the child requires activates with the environment and exercise action within it, the cognitive upgrade construction gets when a child is stimuli in the environment. Activity is one of the interactive factors that affect cognitive growth.

1) Maturity

Piaget believes that maturity is one of the factors of cognitive development and the main contribution of the maturity in the cognitive develop is in neurodevelopment and endocrine system, and the maturation of the nervous system does not do anything more than determine the total number of potential, whether or not done at a certain stage, and social environment remains essential in achieving this potential. Achieving it can accelerate or impede the impact of cultural and educational conditions.

2) Social interaction

Social interaction considered another factor in the development, Piaget means by social interaction is the exchange of ideas between people, social interaction could be in many styles like dealing with comrades, parents and teachers, the events occurring in the classroom are often the interaction between the students themselves and between students and their teachers and all of this is important to the cognitive development.

***2.1.6.2 Vygotsky Theory***

Vygotsky developed concepts of cognitive learning zones. The Zone of Actual Development (ZAD) occurs when students can complete tasks on their own. There is nothing new for the students to learn. In this zone, the students are independent.

The Zone of Proximal Development (ZPD) requires adults or peers to provide assistance to students, who cannot complete the assigned task without help. The ZPD is the gap between what learners are able to do independently, and what they may need help in accomplishing (Daniels, 2001). Instruction and learning occurs in the ZPD. When students are in this zone, they can be successful with instructional help.

Social interaction plays an important role in student learning. It is through social interaction that students learn from each other, as well as adults. Fogarty (1999) stated, "Vygotsky's theory suggests that we learn first through person-to-person interactions and then individually through an internalization process that leads to deep understanding" (p. 77). Vygotsky explores three different types of speech: social, private, and internal. He refers to social speech as the instructions given by adults to children. Private speech allows children to process what the adult has said and try to apply it to similar situations. For example, a teacher tells the class to keep their hands to themselves. Self-control is an example of private speech because children are using for themselves the same "language that adults use to regulate behavior" (Wilhelm, 2001:11).

### 2.1.7 Material Reviews

Scientific notation is one of the material on the curriculum for Junior High School grade 7 in Taiwan. This chapter is taught in grade 7 semester 1. In this chapter, the students are be able to:

1. Determine scientific notation for numbers greater than zero
2. Compare and order fractions, decimals, percents, and numbers written in scientific notation.
3. Multiply and divide the numbers in scientific notation

***2.1.7.1 Scientific Notation***

2.1.7.1.1 Writing Numbers in Scientific Notation

Scientific notation is a system developed by scientists and mathematicians to express very large or extreme numbers. Scientific notation provides a place to hold the zeroes that come after a whole number or before a fraction. The number 100,000,000 for example, takes up a lot of room and takes time to write out, while 108 is much more efficient.

Though we think of zero as having no value, zeroes can take a number much bigger or smaller. Think about the difference between 10 dollars and 100 dollars. Even one zero can make a big difference in the value of the number. In the same way, 0.1 (one-tenth) of the US military budget is much more than 0.01 (one-hundredth) of the budget.

The small number to the right of the 10 in scientific notation is called the exponent. Note that a negative exponent indicates that the number is a fraction (less than one).

The line below shows the equivalent values of decimal notation (the way we write numbers usually, like "1,000 dollars") and scientific notation (103 dollars). For numbers smaller than one, the fraction is given as well. The ilustration can be seen from the table 2.2 below.

Table 2.2 Visualization of Scientific Notation

| **Smaller** | | | | **Bigger** | | |
|---|---|---|---|---|---|---|
| **Fraction** | $\frac{1}{100}$ | $\frac{1}{10}$ | | | | |
| **Decimal Notation** | 0.01 | 0.1 | 1 | 10 | 100 | 1,000 |
| **Scientific Notation** | $10^{-2}$ | $10^{-1}$ | $10^{0}$ | $10^{1}$ | $10^{2}$ | $10^{3}$ |

2.1.7.1.2 Add and Subtract in Scientific Notation

To add or subtract two numbers in scientific notation, you first need to convert them to the same power.

For example, $5\times10^3 + 4\times10^5$

$= 5\times10^3 + 400\times10^3$

$= 405\times10^3$

$= 4.05\times10^5$

This is just the same as we would normally do like in table 2.3 below.

Table 2.3 Visualization of Addition

| **The Numbers in Usual Form** | **The Numbers in Scientific Notation** |
|---:|---:|
| 5000 | $5\times10^3$ |
| +400000 | $+400\times10^3$ |
| = 405000 | $= 405\times10^3$ |

The same idea is used when subtracting,

$$2\times10^{-3} - 8\times10^{-4} = 20\times10^{-4} - 8\times10^{-4} = 12\times10^{-4} = 1.2\times10^{-3}$$

This might be easier to visualise as in table 2.4 below.

Table 2.4 Visualization of Subtraction

| **The Numbers in Usual Form** | **The Numbers in Scientific Notation** |
|---:|---:|
| $0.0020$ | $20\times10^{-4}$ |
| $-0.0008$ | $8\times10^{-4}$ |
| $= 0.0012$ | $12\times10^{-4}$ |

2.1.7.1.3 Multiply and Divide in Scientific Notation

To multiply numbers with the same base, add the exponents.

$$a^b \times a^c = a^{b+c}$$

For example:

Exampe 1. $10^3\times10^5 = 10^{3+5} = 10^8$.

Example 2. $100\times10^3 = 10^2\times10^3 = 10^{2+3} = 10^5$.

What is the power of power? $(a^b)^c = a^{b\times c}$

To divide numbers with the same base, subtract the exponents.

$$\frac{a^b}{a^c} = a^{b-c}$$

For example:

Example 1. $\frac{10^9}{10^4} = 10^{9-4} = 10^5$.

Example 2. $\frac{10^9}{10^{15}} = 10^{9-15} = 10^{-6}$.

But what if b-c gives zero?

If b-c is zero, then the exponents were the same and this is the same as dividing a number by itself which of course gives one or it can be written $a^0 = 1$.

Once the students understand that $10^a \times 10^b = 10^{a+b}$ then it becomes clear that the values for a and b do not need to be integers. For example, consider the following,

$$10^{0.5} \times 10^{0.5} = 10^{0.5+0.5} = 10^1 = 10$$

This is the same as writing : $10^{\frac{1}{2}} \times 10^{\frac{1}{2}} = 10^{\frac{1}{2}+\frac{1}{2}} = 10$ which is the same as : $\sqrt{10} \times \sqrt{10} = 10$.

Similarly $10^{\frac{1}{3}} \times 10^{\frac{1}{3}} \times 10^{\frac{1}{3}} = 10$ is the same as writing : $\sqrt[3]{10} \times \sqrt[3]{10} \times \sqrt[3]{10} = 10$. The symbols $\sqrt{\phantom{x}}$ and $\sqrt[3]{\phantom{x}}$ are typically only used for square roots and cubed roots i.e. $10^{\frac{1}{2}}$ and $10^{\frac{1}{3}}$ respectively.

## 2.2 Review of Relevant Research

Review of the previous research mention of some researchers which have done in the same topic. They can be used as references in this research. The researchs in this topic include the researchers below.

Syarifah and Yosaphat Sumari (2015) conducted a research entitled "Developing A Physics Instruction Model Based On Malcolm's Modeling To Improve Critical Thinking Skills And Learning Motivation". This research aimed to (1) develop a physics instruction model based on Malcolm's modeling method, which is eligible for school and (2) reveal if the physics instruction model based on Malcolm's modeling method can develop the critical thinking skills and learning motivation of students. This research was research and development (R& D) adapting the developmental procedure of Borg and Gall consisting, of (1) research

and information collecting, (2) planning, (3) developing preliminary form of product, (4) preliminary field testing, (5) main product revision, (6) main field testing, (7) operational product revision, and (8) disseminating. The subjects of the preliminary field testing were 36 students of class X MIA 6, SMA N 7 Yogyakarta. The subjects of main field testing were 36 students of class X MIA1 as the experiment class and 34 students of class X MIA 5 as the control class in SMA N 7 Yogyakarta. The data were collected using a test to measure the critical thinking, questionnaires to measure the learning motivation of the students, student response questionnaires and observation sheet. The data were analyzed using MANOVA with the significance level of 5%. The result of this research shows that the physics instruction model based on Malcolm's modeling method in terms of syntax, social system, principles of reaction, support system, instructional and nurturant effect is eligible for the school which is in a very good category according to the validator. The result of MANOVA showed that the model can be used to develop critical thinking skills and learning motivation.



## 2.3 Thinking Framework

Mathematics is one of the subjects that needs reasoning and logic to solve the problem. Problem solving skill is very essential to explore in this subject. Nevertheless, based on observation in school, there are some students did not understand and did not know what they are going to do to solve the problem. The students do not apply scientific method properly, such as identification the problem,

formulate the hypotheses, arrange the steps, and analyze the data. Therefore, the students are not active in learning.

Based on those problems, the teachers need to apply the learning model which makes all the students are active in learning mathematics in class. Constructivism learning is one of the solution to overcome those problems. Syarifah (2015) argued that, in constructivism approach of view the learning is not directly from the teacher, but the students have to formulate by themselves based on their understanding. One the learning method that suitable with constructivism learning is Malcolm's modeling method.

Malcolm's Modeling Method consists of two main stages, those are model development and model deployment. In model development stage, the students use scientific method to construct a hypothesis, do experiment, analyze data and make conclusion. In model deployment the students apply the model to solve the problem.

Syarifah argued that modeling learning can be used to improve problem solving skill mathematics of the students (as cited in Sujarwanto, 2013, p.65). Malcolm's modeling method is suitable with the learning in school which can be observed from syntax social, social system, reaction principal, supporting system, and instructional effect. The comparation between Modeling Method and Malcolm's Modeling Method is shown in the following table 2.5.

Table 2.5 Comparation between Modeling Method and Malcolm's Modeling Method

| **Modeling Method** | | | **Malcolm's Modeling Method** | | |
|---|---|---|---|---|---|
| Syntax | Activity | | Syntax | Activity | |
| | Teacher | Student | | Teacher | Student |
| | | | Orientation Stage | √ | √ |
| Development Stage | | √ | Construction Stage | √ | √ |
| | | | Discovery Discussion Stage | | √ |
| | | | Application Stage | | √ |
| Deployment Stage | | √ | Application Discussion Stage | | √ |

In the orientation stage, the students are given the problem based on daily life application. The students can ask the teacher and construct the hypothesis. This stage can make the students connect the knowledge they knew and new knowledge by providing daily life problem.

In the construction stage, the students construct the steps of doing the problem. Meanwhile, in the development model of Malcolm's Modeling Method, the students construct their solution of problem by themselves. In addition, the stage of discovery discussion stage, the students make evaluation from the previous stage.

In the application stage, the students apply the model in groups in school and individually as homework. Beside that, in the model deployment, the students do the model application in school.

The social system is used on Malcolm's Modeling is a two-way interaction. Each stage of Malcolm's Modeling shows the interaction between teacher and students and between students and students. Teacher and student interaction occurs

in Malcolm's Modeling entire stage. Phase "orientation stage", provides an opportunity for students to ask when presented with a phenomenon. Interaction educators and students on stage "construction" occurs when students find difficulties during the learning activities and teacher is obliged to guide and directing students to not frustrating. Role educators only act as a facilitator in each stage of learning. At the stage of "implementation", educator provides an opportunity to the student to ask if there are things that are not yet understood. At the stage of "discovery discussion " and "discussion of the application", teacher has right to justify the students's answer.

The implementation of Malcolm's Modeling Based on KWL Thinking Strategy makes the students get easy to solve the problem because they understand the question by making an outline in every question. In this model, the students try to improve their problem solving skills related to daily life application. The thinking framework in this research can be seen in the following figure 2.1.

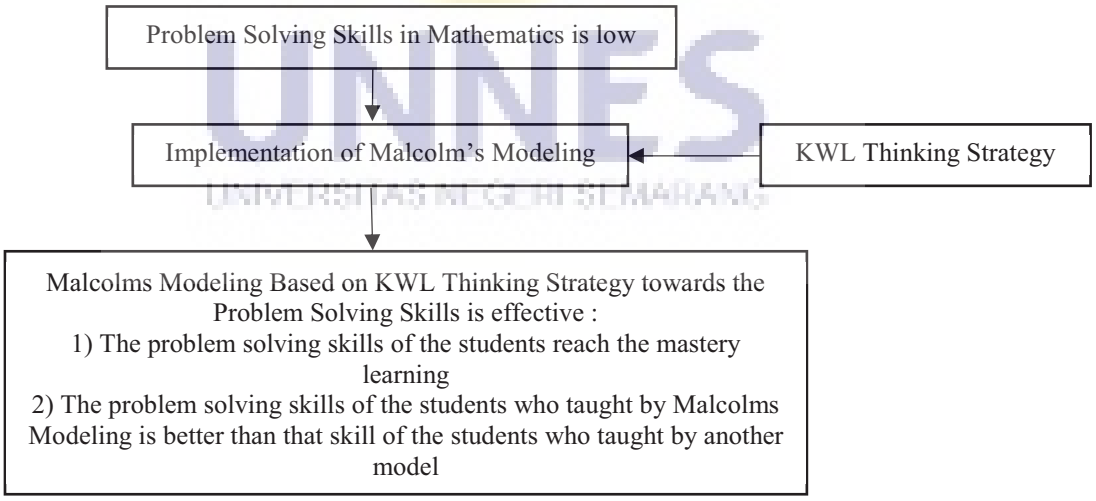


Figure 2.1 Thinking Framework

## 2.4 Hypotheses

Based on framework of thinking, it can be written the hypotheses of this research as follows:

1. Problem solving skills of the students who received Malcom's modeling based on KWL thinking strategy reach the mastery learning individually and classically.
2. The problem solving skill of the students who received Malcom's Modeling using KWL Thinking Strategy is better than that skill of the students who received expository learning model.

# CHAPTER V

# CONCLUSIONS AND SUGGESTIONS

## 5.1 Conclusions

Based on research results and discussions in the chapter IV, it was obtained the conclusions as follows.

1. The results of the research showed that Malcolm's Modeling based on KWL Thinking Strategy gained good result to the score of the students. It was seen from the proportion test that scores of the students in experiment class were passing the classical standard with the proportion more than 75%. Based on calculation, 86% of the students passed the mastery learning.
2. The problem solving skill of the students who received Malcom's Modeling using KWL Thinking Strategy is better than that skill of the students who received expository learning model.

## 5.2 Suggestions

The researcher hopes that the results of the research can give benefit in the education field in order to improve quality of education especially in mathematics. The following statement are the suggestions from the researcher.

1. Malcolm's Modeling based on KWL Thinking Strategy can be implemented in mathematics lesson towards the problem solving skills in the material of scientific notation.

2. The teacher should give challenging problem or question in order to make the students interested in learning the material.
3. Malcolm's Modeling based on KWL thinking strategy can be implemented in another material which has same characteristics with scientific notation.

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