MATHEMATICAL CONNECTION ABILITY THROUGH *DISCOVERY LEARNING* ON GCD AND LCM USING MANIPULATED PROPS IN HANOI, VIETNAM

a final project

structured as one of the requirements

to obtain a Bachelor's degree

in Mathematics Education

by

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DECLARATION

I declare that this thesis without plagiarism, and if later proven the plagiarism contained in this paper, so I am willing to accept sanctions in accordance with legislation.

Semarang, 17th February 2017

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AUTHENTICATION

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MOTTO

- I have not failed. I've just found 10.000 ways that won't work (Thomas A. Edison)
- Verily, along with every hardship is relief. Along with every hardship is relief. (QS. Al-Insyiroh: 5-6)

DEDICATION

- To my beloved parents, they are Mr. Suyitno as my father and Mrs. Rosalia Aristiati as my mother, and all of my family that always giving motivation.
- To my lovely bestfriends.
- To my Mathematics Education' friends.

FOREWORD

Author Praise to Allah SWT for all His grace and guidance, as well as greetings is always devoted to the Prophet Muhammad so that I can finish the thesis with the title Mathematical Connection Ability Through *Discovery Learning* on GCD and LCM Using Manipulated Props in Hanoi, Vietnam.

The author realizes that this thesis cannot be resolved without their guidance and support from various parties. Therefore, the authors would like to thanks:

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12. All those who have helped.

The author also aware that in the preparation of this thesis is still not perfect yet. Author hopes this paper useful for the reader.

Semarang, February 2017

Writer

ABSTRACT

Septiani, R.N. 2017. *Mathematical Connection Ability Through Discovery Learning on GCD and LCM Using Manipulated Props in Hanoi, Vietnam*. Skripsi. Mathematics Department Mathematics and Natural Sciences Faculty Semarang State University. Adviser I: Dr. Masrukan, M.Si. and Adviser II: Dr, Mulyono, M.Si.

Keyword: mathematical connection; manipulated props; *Discovery Learning*

In Vietnam, mathematical connection ability is one of mathematics learning aspect that should be measured. But the level of mathematical connection ability is still relatively low, because the students have not been given a great opportunity to solve problems independently. Although *Discovery Learning* (DL) using manipulated involves students actively in the learning process, but it has not been implemented in Vietnam.

This researh is purposed to (1) examine whether the mathematical connection ability of students who learn DL using manipulated props is reach the mastery learning; (2) examine whether there are any the difference of mathematical connection ability of students who learn using DL with manipulated props, DL, and conventional learning in Vietnam; and which one is the best learning. The population of this research are the students class VI 2016/2017 at Pascal Secondary School, Hanoi Vietnam, with all of the classes as a sample. By *sample random sampling* technique it was obtained that class VI B as experiment class 1, class VI C as experiment class 2, and VI A as control class. The data analysis methods for this research were the right proportions test, ANOVA, equality test proportion and Scheffe as a continuing test.

The conclusion of this research are (1) students' mathematical connection ability by DL using manipulated props is reach the mastery learning, (2) there is a difference between mathematical connection ability by DL using manipulated props (DL+MP), using DL, and using conventional learning in Vietnam (C); and students' mathematical connection ability by DL+MP better that DL, and better than C.

Based on the conclusion, that are some suggestions: (1) teacher in applying DL using manipulated props always supervise students activites in the group discussion, that students who have difficulties can directly ask, therefore the time was more efficient, and (2) teacher in applying DL using manipulated props should prepare props more because most students want to try using props by themselves.

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CHAPTER 1

INTRODUCTION

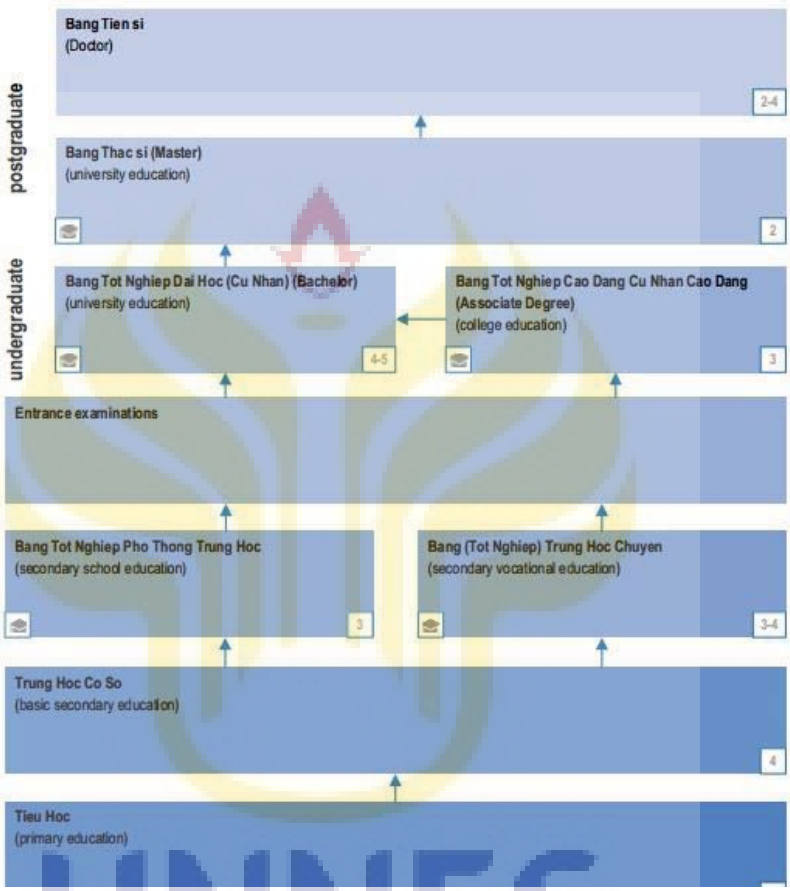
1.1 Background of the Study

Education has a very important role to create quality human resources. Educational process carried on in school is basically learning activities, which aims to enable students to have the best results-according to his abiliy. One benchmark which ilustrates the level of students success in learning is the result of learning. The result of learning can be seen from three aspects. They are cognitive, affective, and psychomotor aspects.

According the TIMSS in mathematics learning, students are not only taught to simply memorize math formulas but they should also be able to use mathematics to Solve problems that exist around their lives. Mathematics problems related to daily life in mathematics will make students know and understand the benefits of knowledge that they have learned.

Education in Vietnam is divided into five levels. They are preschool, primary school, secondary school, high school, and higher education. Formal education consist of three levels of education. They are Primary Education (Tieu Hoc), Basic Secondary Education (Trung Hoc Co So), Secondary School Education (Bang Tot Nghiep Pho Thong Trung Hoc), or Secondary Vocational Education (Bang (Tot Nghiep) Trung Hoc Chuyen). Primary Education is reached over 5 years for children ages 6-11 years. Basic Secondary Education is reached over 4 years for children ages 11-15 years. While Secondary School Education and Secondary

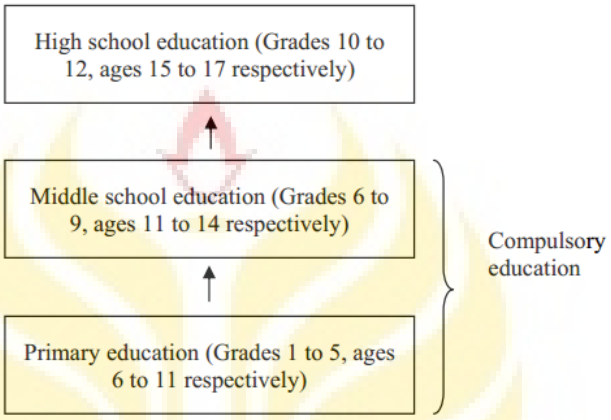
Vocational Education is a tiered same school. In Indonesia they are SMA and SMK. This education is reached over 3 years for children ages 16-18 years. Education system in Vietnam is listed as following the picture 1.1.



Picture 1.1 Vietnam Education System

According Tran Thi Tuyet (2013), education system in Vietnam generally, especially in Higher Education System (HES) does not push and does not even allow the students to take their learning style freedom. HES is an education system that manage in the higher education leraning, such as te students in Secondary School Education or Secondary Vocational Education. Therefore the students can not take full responsibility for their school. Then Vietnam still needs to work hard to solve the internal problems in the field of HES.

According to the Vietnam National Aseembly, national education system consist of preschool education, basic education, vacotional education, postgraduate, and graduate education. Basic education consist of primary, secondary, and high education which is ilustrated in the following picture 1.2.



Picture 1.2 Vietnam National Education System

The main purpose of Milennium Development Goals (MDGs) and Proverty Reduction Strategies (PRS) to developing countries is focusing on participation in international development at the primary education level. There are international pride of the countries where the registration of secondary school students have a high enough rating in recent years. Vietnam is one of these countries (Ha and Harpham, 2005). According to National Exam of Vietnam the registration of secondary school increased from 87 % in 1993 to 91% in 1998 and now the possibility of reaching 92%.

Vietnam national mathematics curriculum is designed by the Ministry of Education and Training. According MOET that quoted by Vui (2014), school reforms in mathematics education aim to help students achieve the following four objectives: knowledge, skills, thinking and attitudes. Tuan Anh Lee (2006) stated

that the teaching and learning of mathematics has a very important role in the development process of education in Vietnam. In Vietnam, mathematics is often considered as the main subject of school. Mathematics is learned from grade 1 to 12 in Vietnamesse school. Even, mathematics always appears at the test of school diploma. Based on International Mathematics Union' data compiled in the table below, shows that there are major gaps in the number of publications between Singapore and other countries in Asean.

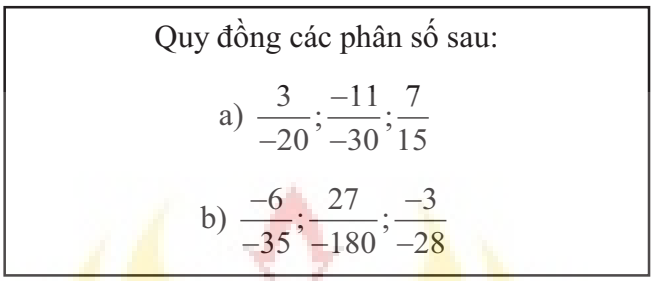
Tabel 1.1 Mathematical Concept Understanding in ASEAN

Country	Mathematics	Combinatoric	Algebra	Apl Math	Statistics
Singapore	14.864	502	4.804	7.524	27.307
Malaysia	6.911	116	683	4.184	16.133
Thailand	4.922	82	760	2.756	20.707
Indonesia	3.022	85	246	1.579	11.569
Vietnam	2.117	55	624	1.101	9.425
Philippines	1.355	67	179	620	8.546
Laos	1.196	41	152	651	4.642
Brunei	450	3	56	184	739
Cambodia	152	0	12	72	2.027
Burma	111	3	8	54	933

Source : International Mathematics Union

It appears that Singapore deminater in the understanding of mathematical concepts. In the field of mathematical applications is neraly the same as the mathematical connections in Indonesia. Because the application of mathematics is the use of mathematics to other sciences of daily life.

Mathematical connection ability is one of aspect that is measured in Vietnam. It can be seen from some of the questions presented is one of indicator of the mathematical connection. As directed by the following picture 1.3.

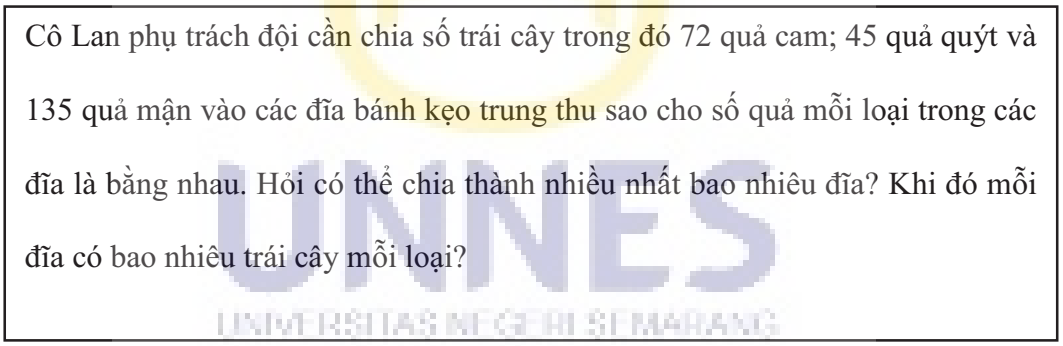

Quy đồng các phân số sau:

a) $\frac{3}{-20}; \frac{-11}{-30}; \frac{7}{15}$

b) $\frac{-6}{-35}; \frac{27}{-180}; \frac{-3}{-28}$

Picture 1.3 The example of Vietnam mathematics question that one of indicator of mathematical connection, that is connection between mathematics (MC 1)

That question about fraction with different denominator. Therefore to completing that problem students must change the denominator for each fraction with same number. They can do it by the Least Common Multiplies (LCM) concept.


Cô Lan phụ trách đội cần chia số trái cây trong đó 72 quả cam; 45 quả quýt và 135 quả mận vào các đĩa bánh kẹo trung thu sao cho số quả mỗi loại trong các đĩa là bằng nhau. Hỏi có thể chia thành nhiều nhất bao nhiêu đĩa? Khi đó mỗi đĩa có bao nhiêu trái cây mỗi loại?

Picture 1.4 The example of Vietnam mathematics question that one of indicator of mathematical connection, that is connection between mathematics with daily life (MC 3)

That question about the daily life problem, Mr. Lan has some fruits, and he is asked to search how many fruit can be presented on the plate, and calculate how many fruit in each in a plate. To completing this problem, firstly students must know about the Greatest Common Divisor concept.

According to NCTM as stated by Saminanto (2015), if students can connect mathematics ideas, their mathematics understanding will more increase because they can see the relationship between one topic and the other topic, the rellationship between topic in mathematics and science, and the relationship between mathematics and daily life experiences.

Based on the test can be concluded that the ability of students in connecting one idea with another idea to produce all linkage is still low. Therefore it needs a good learning method to reduce the gap of student learning and can increase the ability of students to connect an idea with another idea.

According to National Council of Teacher of Mathematics states that:

> ... mathematics learning in schools from primary education up to calss XII require learning standards that serve to produce student who has the ability think, the ability of mathematical reaSoning, has the knowledge and basic skills helpful. Standard of learning includes standards of content and standards of process. Standard of content is the standard of mathematics learning that include the concept of material that must be learned by students, in example: number and operations, algebra, geometry measurement, data analysis, and opportunities. While the standrad of process are the abilities that must be own by the students to achieve the standard of content. Standard of process includes : problem Solving, reaSoning, communication, connections, and representation.

According to Wena (2009:107) in the implementation of learning in the classroom, teacher will find a variety of problems, both students problem, methodological problem. All these problems certainly impaceted directly or indirectly to the achievement of leraning outcomes. All these problems should be regarded as a challaenge, to achieve the learning objectives that have been set. Therefore, a teacher must have a specific strategy to face these problems. In order to create a condition of learning that is active, creative, effective, and fun for students, among other is required he pplication of appropiate earning approach. To

achieve these expectations, teacher must be skilled in choosing the right approach to the subject is presented and the characteristics of students, experienced teachers will have a better ability in selecting the appropriate learnig with the subject will be taught and the needs of students.

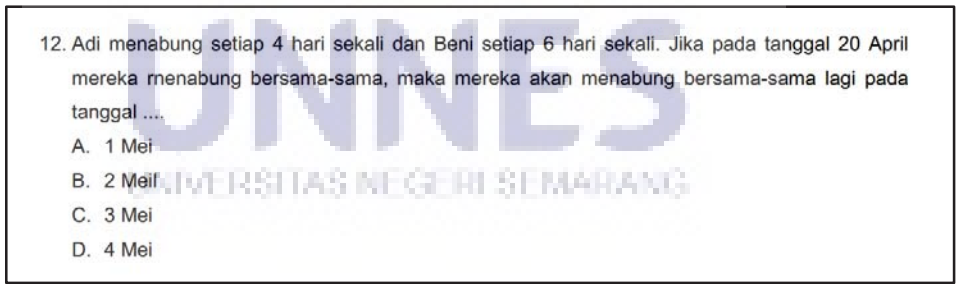
According Prastiwi *et al*. (2014) mathematical connection must be increased for students, therefore efforts are needed to create learning teacher who directs the students to know these linkages, as well as create an atmosphere of active learning so that students' motivation is increasing. To improve students mathematical connection, teachers can choose the best learnign. In this case, the writer will choose two possible models of learning that can improve students' mathematical connection. The learning model is Discovery Learning (DL), Discovery Learning is methode that encourage students to get a conclusion based on the activities and their observations (Lee, Mann, and Frank in Aziz, 2014). Therefore, the writer assume that by using Discovery Learning, the ability level of mathematics connecton of students will increase.

The ability of students' mathematical connection are still lacking. It will use the learning model that is visual aid to facilitate the integration of learning in the Discovery Learning. Because of through the use of good visual and media, the syntax in Discovery Learning can be fullfilled maximally. For example during the second phase of Discovery Learning process, namely the identification of problem. In this phase student is faced by a problem. The teacher gives the problem in the form of manipulated props, the students are asked to anlyze how to deal with these problems. Then the teacher gives the oportunity to collect data according to their

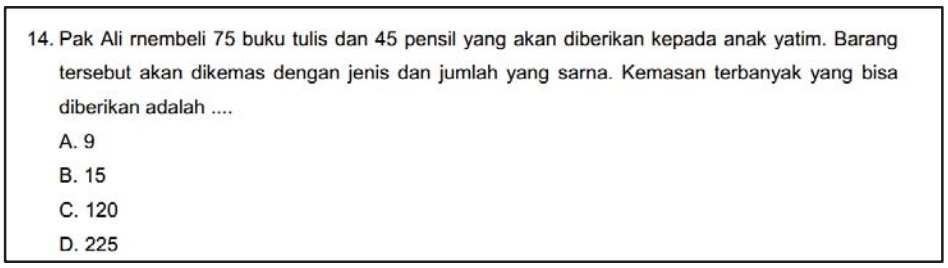
problems using the manipulated props. This phase is the third phase of *Discovery Learning*, that is data collection. Activities observe a model, form, and the use of manipulated props is the fulfillment of the visual aspect, while the intellectual aspect indicated by the students associate the initial explanation of teachers with new knowledge So that they are able acquire knowledge and new discoveries of the manipulated props and can use it to conenct with various another aspect.

According Setyowati *et al.* (2016) the causing of low mathematics learning result is learning methods provided by the teacher lower. This is certainly a significant impact on student learning outcomes. In addition to the type of learning model variations that affect learning, instructional media utilization was also influential. Thus, in this study the author uses manipulated props as a learning media, so as to increase student interest in learning.

Some of the problems relating to the material GCD and LCM is shown by the following figure.


12. Adi menabung setiap 4 hari sekali dan Beni setiap 6 hari sekali. Jika pada tanggal 20 April mereka menabung bersama-sama, maka mereka akan menabung bersama-sama lagi pada tanggal ....
A. 1 Mei
B. 2 Mei
C. 3 Mei
D. 4 Mei

Picture 1.5 The example of LCM question that can be increased the students mathematical ability


14. Pak Ali rnembeli 75 buku tulis dan 45 pensil yang akan diberikan kepada anak yatim. Barang tersebut akan dikemas dengan jenis dan jumlah yang sarna. Kemasan terbanyak yang bisa diberikan adalah ....
A. 9
B. 15
C. 120
D. 225

Picture 1.6 The example of GCD question that can be increased the students mathematical ability

The questions above can be categorized as a matter that can improve students mathematical connection because students are required to connect between the concept of GCD and LCM with the daily problems. The students are required to think in order to solve these problems and can write the conclusion.

Based on the description above, in order to increase student mathematical connection ability the writer choose the title "Mathematical Connection Ability Through *Discovery Learning* on GCD and LCM Using Manipulated Props in Hanoi, Vietnam".

1.2 Problem

Based on the background of study, the formulation of the problem that are discussed in this study are as follows:

1. Does the students of mathematical connection ability who learn *Discovery Learning* using manipulated props on GCD and LCM reach the mastery learning?
2. Is there any differences of mathematical connection ability among students who learn *Discovery Learning* using manipulated props, students who learn *Discovery Learning*, and students who learn conventional learning in Vietnam? Which one is the best?

1.3 Objective

The objective of this study are as follows:

1. To know the students of mathematical connection ablity who learn *Discovery Learning* using manipulated props on GCD and LCM is reach the mastery learning.
2. To know the differences of mathematical connection ability among students who learn *Discovery Learning* using manipulated props, students who learn *Discovery Learning*, and students who learn conventional learning in Vietnam, and to know which one is the best learning.

1.4 Significance

1.4.1 The Theoritical Significance

This study is expected to contribute ideas on improving students mathematical connection.

1.4.2 Practical Significance

1.4.2.1 For the reseacher

a. Get an experince in choosing the right model for the leraning process.

b. The result of this study are expected to be a reference the further research

1.4.2.2 For the students

Increase the sense of cooperation and curiousity to prove a particular problems and eventually improve the mathematical connection itself.

1.4.2.3 For the teacher

As reference material or feedback about the learning models that can be used as an alternative in teaching in an effort to increase student achievment.

1.5 Assertion of Term

To avoid misinterpretation or cause Some interpretation in Some iterpreting the title, the it should be given the assertion of term as follows:

1.5.1 Mastery Learning

Learning can be said the success learning if the students can reach the mastery learning. As same as with Indonesia, Vietnam has the criteria of mastery learning. Specially in Pascal Secondary School, a class can be said reach the mastery learning if the percentage of student who reach the mastery learning ismore than 75% from the sum of the student. In Vietnam, specially in Pascal Secondary School, the Minimum Completeness Criteria (MCC) literally nothing. Students are only required to get good grades. But according to observations and interviews with teachers in Pascal Secondary School, if there are students who scored less than 75 then it will be given extra exercises they should do at home. Thus the term remedial there is getting more exercises. In this study, the minimum completeness criteria at least the same with a minimum completeness criteria that used in Pascal Secondary School, which is 75. So if there are students who get score more than or equal to 75, then these students declared complete.

1.5.2 Discovery Learning

Model in this study is finding way of not knowing becoming out by the students themselves. The syntax of Discovery Learning as follows: (1) stimulation, (2) identification of problem, (3) data collection, (4) data processing, (4) verifying, and (5) conclusion.

1.5.3 Mathematics Learning using Manipulated Props

The manipulated props is part of the learning media. Learning media is a tool for sending information or messages for the purpose of learning. Basically, learning media are grouped into two parts, media as a carrier of information (knowledge), and the media as well as to instill the concept.

1.5.4 Mathematical Connection

Mathematical connection emphass on the ability to use mathematical tools, resources, procedures, knowledge and ways of thinking to create a new understanding of the situation. Mathematical connection ability will be needed by studentss, especially to solve a problem that requires relationship between mathematical concepts with other concepts in mathematics and other diciplines or in daily life (Rohendi, 2013).

According to NCTM, indicating that mathematical connection is divided by three aspects, they are: (1) asepct of conenction between mathematical topic (MC 1), (2) the aspect of the connection with other knowledge, and (3) the aspect of the connection with daily life (MC 3).

1.5.5 Criteria of The Best Students' Mathematical Connection Ability

To determine which one is the best students' mathematical connection ability, is used three statistics test, there are one side proportion test, equality test proportion, and Scheffe test. The criteria to determine which one is the best students's mathematical connection ability as follows.

a. The post test data result reach the mastery learning
b. Has the highest proportion value ($\pi_1 > \pi_2 > \pi_3$)
c. Has the highest mean value ($\mu_1 > \mu_2 > \mu_3$)

CHAPTER 2

LITERATURE REVIEW

2.1 Mathematical Connection Ability

2.1.1 Definition of Mathematical Connection

In this era of mathematics education emphasize the need of pedagogy because it offers the opportunity for students to develop their skill in a complex high level cognitive processes. One is always associated with the ability to make mathematical connection, together with the role of teacher in teaching them, with the understanding of mathematics (Mhlolo, 2012).

Mathematical connection emphasizes in the ability to use mathematical tools, resources, procedures, knowledge, and ways of thinking to create a new understanding of the situation. Mathematical connection ability will be needed by students, especially to solve a problem that requires relationship betweem ,athe,atical concept with other concept ini mathematics and other diciplines or in daily life (Rohendi, 2013).

According Wahyudin (2008), as quoted by Mandur et al., (2013: 4), states that if students can relate mathematical ideas then their understanding will be deeper and last longer. They can see mathematical relationships of mutual influence between mathematical topics, in the context of connecting mathematics to other subjects, as well as in the interests and experiences of themselves. Meanwhile, according to Coxford, as quoted by Mandur et al. (2013: 4), the mathematical connection ability is the ability to connect the conceptual and procedural

knowledge, use mathematics on another topic, use mathematics in life activities, find a connection between the topics in mathematics.

Connection and experience are key in education and the following elements are important in the theory of the curriculum: "(a) the interests and learning capacity of children individual; (b) the historical experiences of the children's life; (c) the scientific method of inquiry; (d) various matter types of subject ; (e) social context; and (f) the values of democracy "(Shield in Adnan Baki, 2009).

The ability of students to make connections in mathematics itself is very important for the conceptual understanding as well as for other applications of mathematical discipline itself (Anthony & Walshaw, in Mhlolo 2012). Blum in Mhlolo (2012) showed that the literature has identified two main types of mathematical connections. The first is to recognize and apply mathematics to contexts the outside of mathematics (the link between mathematics, other disciplines or the real world. The second concerns the interconnection between the ideas in mathematics.

Businskas as quoted by Mhlolo (2012) explains that Someone can define the connection of mathematics broadly as: (1) the relationship between ideas or processes that can be used to connect the topics in mathematics, (2) the manufacturing process or recognize relationships between ideas of mathematics, (3) the association of a person may make two or more of mathematical ideas, and (4) a causal or logical relationship or interdependence between two mathematical entities.

According to the NCTM (2000: 274) thinking mathematical involves a search of connection and make connections to build an understanding of mathematics. Without the connection, students must learn and remember too many iSolated concepts and skills. With the connection, they can build a new understanding about knowledge earlier. The most important focus of mathematics at secondary school level is a rational number, and proportionality and linear relationships are all interconnected, so that the secondary school students when faced with a variety of new mathematical content, they have many opportunities to use and make the connection.

Big Indonesian Dictionary (KBBI) means that the connection is a relationship that can facilitate all matters (activity). While the mathematical connection ability is Someone's ability to present internal and external relations of mathematics, which includes the connection between mathematics topics, connections with other disciplines, and connections in daily life. So according Rohendi (2013) the broad sense of the mathematical connection is the link between mathematical topics, between mathematics and other disciplines, and between mathematics and real life or daily life.

According Barmby et all in Mhlolo (2012) finds that one showed a deep understanding of mathematics through: (1) connection is made between different mathematical ideas, (2) different representations of mathematical ideas, and (3) the thinking between different mathematical ideas.

Based on some definitions and opinions about the mathematical connection abilities, it can be concluded that the mathematical connection ability is an ability

to seek, understand the relationship between different mathematical topics and links with disciplines of knowledge in mathematics outside and using mathematics in daily life.

2.1.2 Indicator of Mathematical Connection

According to the NCTM (National Council of Teachers of Mathematics) (2000: 64), the indicator for the mathematical connection ability, namely: (a) Identifying and utilizing the relationships between ideas in mathematics; (b) Understand how ideas in mathematics and underlying interconnected with one another to produce a stability coherent ; (c) Recognize and apply mathematics in the context of mathematics outside. Meanwhile, according to Sumarmo as quoted by Rohendi (2013) explaines a number of indicators in mathematical connection: (1) find the relationship of the various representations of concepts and procedures, (2) understand the relationship between mathematics topics, (3) use mathematics in other studies or daily life, (4) understand the concept of representation equivalent or similar procedures, (5) find a relationship between one another procedure in the similar representation and (6) the connections between mathematics and the mathematical topics with other topics.

According to the NCTM as quoted by Businskas (2008), identified two types of connections: modeling the relationship between problem situations that may arise in the real world or in a discipline other mathematics and their mathematical representations and the mathematical connection between two similar representations and between the corresponding processes. In mathematical connection abilities, students are required to: (1) to connect the inter-topics in

mathematics that connects inter-concept or principle in the same topic, (2) the relationship between topics in mathematics that connects one material and other materials in mathematics, (3) the relationship between mathematics materials and other sciences, (4) the relationship between mathematics and daily life that can be found by students. The ability to connect mathematics in accordance with the theorem connectivity that constructivism theorem and the theorem connectivity described by Jerome S Brunner and supported by the theorem of Jean Piaget about cognitive development and Vygotsky that builds around constructivism.

Connection helps students to understand what they are learning in mathematics. Indicators of mathematical connection by the Singapore Ministry of Education (2013: 32), namely

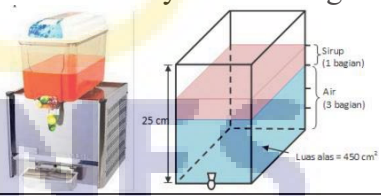
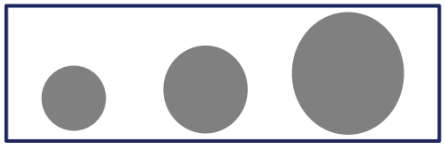
1. making connections in within mathematics
2. making connection between mathematics and daily life

From the explanations above, the writer concludes the indicators of mathematical connection capabilities as follows.

Table 2.1 Indicator of Mathematical Connection

No.	Indicator	Students activity
1.	Making connections in mathematics	Can solve the problem related between one mathematics concepts with each other
2.	Making connections between mathematics and other scientific disciplines	Can solve a mathematics problem that is related to other disciplines, such as Science
3.	Making connections between mathematics and the real world	Can solve the mathematics problem in the context of the real world (of daily life)

Here are examples of questions related to mathematical connections in accordance with the indicator.

No.	Indicator	Examples of questions
1.	Making connections in mathematics	Dispenser shaped block has a 450 cm2 area of the base and 25 cm high. Galina add syrup and water at a ratio of 1:3 to the dispenser for making beverages. If Galina using 6.75 liters of water, what percentage of the dispenser to be fulfilled by the beverages? 
2.	Making connections between mathematics and other scientific disciplines	Known copper cube-shaped to the mass (m) 1 836 grams and its density (ρ) of 8.5 g / cm3. Determine the length of the copper side.(ρ = m/v)
3.	Making connections between mathematics and the real world	You are asked to design a set of new coin. All currencies will be circular and colored silver, but different of diameters.  The writer finds that the ideal currency system that fulfil the following requirements:

		1. The diameter of the currency is not less than 15 mm and not more than 45 mm. 2. If given a currency, then the next currency have diameter of at least 30% greater. 3. Money making machine can produce only currency with a diameter measuring integer with millimeters (eg 17 mm is allowed, but 17,3 mm not allowed). Design a set of currencies that fill all three requirements above. You must start with a currency with a size of 15 mm and the set should contain all sizes possible currency.

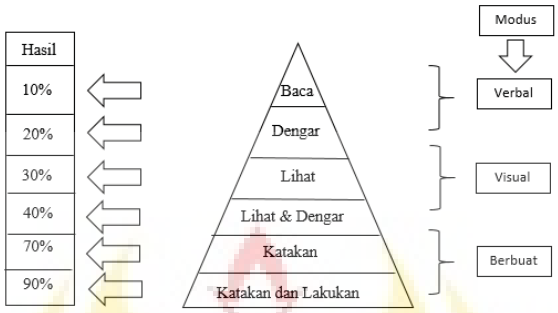
2.2 Manipulated Props in Mathematics Learning

A teacher needs to be aware that the communication did not always run smoothly, which means that the messafe delivered by the teacher can be received in full by the students. The reality shows that communication can cause confusion, misinterpretation and may give errors in understanding the concept (misconception) for students (Sugiarto, 2013:7). So as to reduxe the communication errors that needed a means to help the communication process. The facilities are media or learning tool.

Gagne as quoted by Sugiarto (2013:7) states that the various types of components in the students environment and can stimulate them to learn. Meanwhole, according to Briggs in Sugiarto (2013:7) states that the media is all the physical tools that can present the role and stimulate students to learn.

According Sugiarto (2013:9) the use of appropriate learning media can improve the quality of communication between teacher and students making the

learning more effective. The more senses are used by students in learning better of retention or students' memory as described in the learning experience cone .



Picture 2.1 Learning Experience Cone

Manipulated props is a part of the learning media, according Suherman (2003:238) states that basically learning media are group into two parts, the media as an information carrier (science), and the media as well as a tool instill the concept. The manipulated props of mathematics belongs to the second media type, as an information carries as well as a tool to instill a concept.

Manipulated props object is an object tat is manipulated by teacher in delivering mathematics lesSon So that students understand the concept easily. With the manipulated props is expected that students can be motivated in the learning process. In the process of teaching and learning, the most responsible thing is the way of the teacher teach or convey the lesSon, such as by using manipulated props in teaching. By using manipulated props will provide materials that will be accepted students easily. Moreover, it can attract the attention of students and stimulate student to think, but the use of educational media got to see to whom the media will be given, So that the media used can has a meaning in mathematics learning.

2.2.1 Learning Theory

Relevant learning theories with mathematical connections in this study is Piaget's learning theory and Brunner's learning theory.

2.1.2.1 Piaget Learning Theory

Having the ability to mathematical connection can be shown by their ability to associate the basic concept or knowledge posseesed by any other concept or new knowledge acquired in accodance with the theory by Jean Piaget in Rifa'i & Ainni (2012:32) who believes that every child tries to obtain a balance between assimilation and accomodation by applying equilibrium. Because the children are progressing for their cognitive development, it is importants to maintain a balance between applying the knowledge that has been owned previously (asmilatin) and change the behaviour for their new knowledge (accomodation). Equlibrium describes how children are able to move from the phase of thinking to think the next phase.

2.1.2.2 Jerome Bruner Learning Theory

According to Brunner, as quoted by Suherman (2003:43) that learning mathematics will be more successful if the process is directed at teaching the concepts and the sturctures contained in the instructional materials. The method of the invention is a learning procedure which emphasizes the students learning process to achieve certain goals.

Brunner said, as quoted by Suherman (2003:43) that in the process of learning the child should be given the opportunity to manipulate the objects (manipulated props). Through the manipulated props that he studied, the child willl see directly how the regularities and patterns contained in the structure of the object that is being

noticed. The regularity then by the child is asSociated with intuitive information that has been attached to him. Then, based on his observation of the children's behaviour, Brunnes finally has confidence that there are three phases of cognitive development, as follows.

1. Enactive phase

   At this phase the children understand their environment. The children are seen directly in manipulating.

2. Iconic phase

   At this phase the information is brought by the children through imagery. The activities are done by the children related to mental that is a description of objects that have been manipulated.

3. Symbolic phase

   This symbolic phase provides opportunity for children to develop their ideas densely, such as using images that are related or other forms of formula.

According Rifai & Ainni (2012:38). Children will learn well if they manipulate the object to be studied for example with see, feel, smell, and others. The discovery learning approach or other inductive earning approach will be more effective in the learning rpocess of children. So in this study used a model of Discovery Learning.

Brunner also expresses about Some of the arguments of the result of observations in schools. They are constructions argument (contruction), notation argument, contrast and diversity argument, and attribution argument (connectivity).

This connectivity argument states that in mathematics, from one concept to another there is a close relationship not only terms of content, but also in terms of formulas that are used the are content may be a precondition for the other, or a certain concept is needed to explain other concpets.

The lingkage of this study with the theory of Brunner is that students represent concepts, pouring thought and indofrmastion in the form of notation as well as preparing and presenting the concepts and then connect Some of these concepts to Solve problems. Students learn actively in discussion with the help of the teacher to understand the material So that they can find the concepts and Solve the problems.

2.3 *Discovery Learning* (DL)

2.3.1 Definition od *Discovery Learning* (DL)

According to Brunner (in Balim, 2009) discovery is how to find from does not know to know by students themselves. Basic teaching of knowledge is to understand that the natural phenomena and the characteristic of knowledge require an approach in inquiry (question) and discovery (invention). Inquiry consist of experimentation an natural phenomena inquiry with discovery learning (Balim, 2009).

Discovery learning is a method that encourages students to come to conlusion based on acyivities and their own observations. The activities help to correct the conceptual errors of students (kapan and Korkmaz in Balim, 2009). Meanwhile, according to Eggen and Kauchak (in Rahayu, 2015) discovery learning model is a lesSon plan that present the lesSon material by looking at the certical thinking

process is an integral part of the learning process. From Some of the expert opinion, it can be concluded that the discovery learning is a learning method designed to find concepts an relationship between the concepts by students. While the role of the teacher only as a motivator, facilitator, and manager in learning.

2.3.2 Syntax of *Discovery Learning* (DL)

According to Syah (2008:244) in apllying the discovery learning in the classroom, there are Some procedures that must be implemented in teaching and learning activities generally are as follows:

2.3.2.1 Stimulation

First of all at this phase students are exposed to Something that raise a question mark, then continued to not give a generalization, that the desire to investigate themselves. In addition, the teacher can start learning activities by asking question, suggestion of reading books, and other learning activities that lead to the preparation of problem Solving.

2.3.2.2 Problem Solving (Statement/Identification of Problem)

After stimulation the next step is the teacher allows students to identify as musch as possible the agenda of problem relevants to learning materials, that one of them is colected and formulated in hypothetical form (temporary answer to the question of problem), according Syah (2008:244). The problem which is selected then must be formulated in the form of a questions or hypothesis, that statement as a answer to questions.

Giving students the opportunity to identify and analyze the problen they face, is a useful tecnique in building students So that they are accustomed to find a problem.

2.3.2.3 Data Collection

When the exploration is carried out teacher also give an opportunity for students to collect as musch informtions relevant to prove the correctness of the hypothesis (Syah, 2008:244). At this phase serves to answer questions or to prove the truth of the hypothesis.

Thus, students are given the opportunity to collect (collection) of various relevant information, read the literature, observing the object interview with Sourcesm conduct their own trials and So on. The consequence of this phase is students learn actively to find Something related to the problems faced. Thus inadvertently students connect the problem with the knowledge that gas been owned.

2.3.2.4 Data Processing

All information on the result of reading interviews, observations, and So on, are all processed, randomized, classifie, tabulated, even if it is calculated in a certain way and interpreted at a certain confidence level. Data processing is also called the encoding/categorization that serves as the formation of concept and generalization. From generalization that students will get new knowledge about alternative answer/Solution that need a proof logically.

2.3.2.5 Verification

At this phase, the students do a careful examination to prove whether correct or not the earlier hyphothesis by finding alternative asSociated with the result of data processing (Syah, 2008:244). Verification according to Brunner, aims to make the learning process will go well and creative if the teaceher gives students the chance to find a concept, theory, rules or understanding through example that they see in their life. Based on the result of processing and interpretation or information questions or hypothesis that have been formulated earlier then checked, wheter answered or not, wheter proven or not.

2.3.2.6 Generalization

Phase of generalization or draw conlusion is process of drawing a conclusion that can be used as a general principle and apply to all event or the Some problem, with regard to the result of verification (Syah, 2008:244). Based on the result of verification then formulated the principles that undelie generalization. After concluding the students must pay attention to the process of generalization that emphasizes the importance of mastering a lesSon on the meaning and rules or principles of broad underlying one's experience as well as the importance of regulatory process and the generalization of these experineces.

2.3.3 Syntax of Discovery Learning Using the Manipulated Props

Syntax of learning model of discovery learning using manipulated props in this study like syntax in learning of discovery learning, but the learning is asissted by manipulated props. The syntax can be presented with a table 2.1.

Table 2.2 Syntax of Discovery Leaning using the manipulated props

NO	Phase	Syntax of *Discovery Learning*	The Use of Manipulated Props
1	*Stimulation*	Teacher gives problems or questions and does not give a generalization that generate curiosity in the students	
2	*Problem Statment*	Student identify and analyze the problems they face	Used to help students in analyzing problems concretely
3	*Data Collection and Processing*	Giving studnets the opportunty to collect a variety of relevant information	Help students to finding a concept when thet collect data and Solve the prolems
4	*Verification*	A careful examination to prove whether correct or not of the data that students collect through presentations	Used duurng the presentation So that every studnts knows that use of manipulated props
5	*Generalization*	Drawing conclusions by students with the help of teacher	Teacher give example of using the rifght manipulated props

2.4 Material Overview Great Common Divisor (GCD) and Least Common Multiplies (LCM)

2.4.1 The Greatest Common Divisor (GCD)

GCD in mathematics is the Greatest Common Divisor. GCD is one kind of algebra material in mathematics. In this case the alliance is counting and looking GCD of a prime value through GCD factors tress and the prime number factorization. There are three ways to search for GCD of an integer, by calculating

the alliance multiples, with prime factorization, and using a table. These are the example of the GCD question.

1. Determine the GCD of 6 *and* 8.

   Solving:

   $6 = 2 \times 3$

   $8 = 2^3$

   So the GCD of 6 *and* 8 is 2.

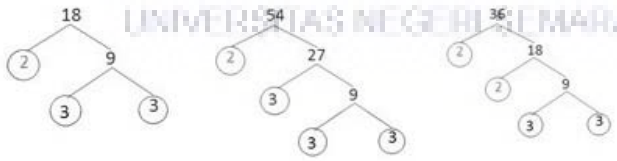
2. Hani has a red ribbon along 18 meters, blue ribbon along 54 meters, and yellow ribbon along 36 meters. All of them will be used to decorate a gift box as much as possible with the same length and color of each box. What is the highest number of gift boxes which can be decorated?

   Solving :

   Given: red ribbon along 18 meters, blue ribbon along 54 meters, and yellow ribbon along 36 meters.

   Question: the highest number of gift boxes which can be decorated

   Answer :



   $18 = 2 \times 3^2$

   $54 = 2 \times 3^3$

$36 = 2^2 \times 3^2$

Therefore the GCD of $18, 54, and\ 36$ is $2 \times 3^2 = 18$.

So, the highest number of gift boxes which can be decorated is 18 boxes.

2.4.2 The Least Common Muliplies (LCM)

LCM understanding in mathematics is seeking value with the Least Common Multiplies or LCM of the two smallest integer that can be divisible by both numbers. Similarly, the search for GCD, there are three ways to seek LCM of an integer, by calculating the alliance multiples, with prime factorization, and using a table. These are the exampleof LCM question.

1. Determine the LCM of 6 and 8.

   Solving:

   $6 = 2 \times 3$

   $8 = 2^3$

   So the LCM of 6 and 8 is $2^3 \times 3 = 24$.

2. Mila and Sari are following the piano lesson at the same place. Sari is doing the exercise every 6 days, Mila is doing the exercise every 4 days. If today they les together, how many days they doing the exercise together again?

   Solving:

   Given: Sari is doing the exercise every 6 days, Mila is doing the exercise every 4 days.

   Question: how many days they doing the exercise together again.

Answer:

$6 = 2 \times 3$

$4 = 2^2$

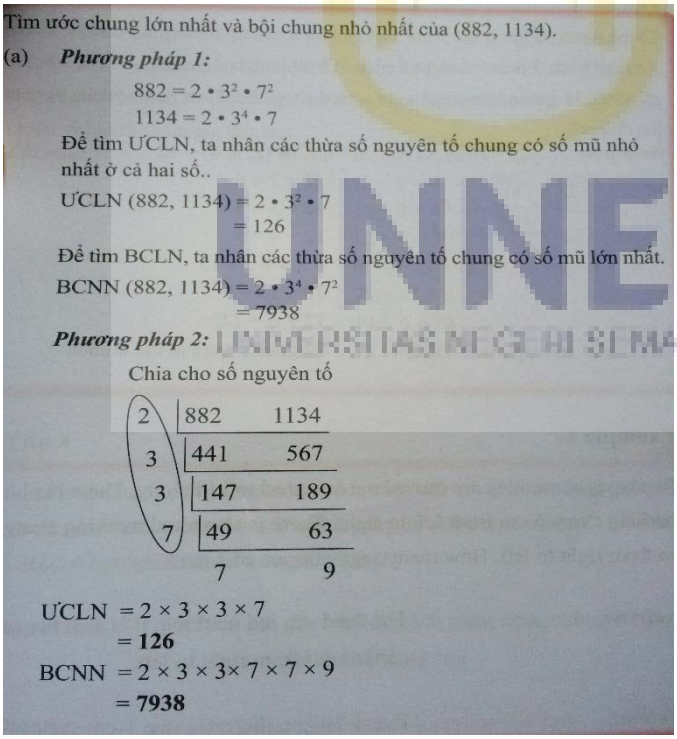
So the LCM of 6 and 4 is $2^2 \times 3 = 12$.

So they will doing exercise together again after 12 days from today.

According the first example of GCD and LCM, we know that the GCD of 6 and 8 is 2, and the LCM of 6 and 8 is 12. Therefore it can be concluded that $GCD \times LCM = 6 \times 8$.

2.4.3 The Example of GCD and LCM on Mathematics Learning in Vietnam

As same as Indonesia, Vietnam has GCD and LCM material in grade sixth. But in Vietnam, grade sixth is include to the secondary school. According to Chew (2016:184), these are the example of GCD and LCM problem.



Tìm ước chung lớn nhất và bội chung nhỏ nhất của (882, 1134).

(a) ***Phương pháp 1:***

882 = 2 • 3² • 7²

1134 = 2 • 3⁴ • 7

Để tìm ƯCLN, ta nhân các thừa số nguyên tố chung có số mũ nhỏ nhất ở cả hai số..

ƯCLN (882, 1134) = 2 • 3² • 7

= 126

Để tìm BCLN, ta nhân các thừa số nguyên tố chung có số mũ lớn nhất.

BCNN (882, 1134) = 2 • 3⁴ • 7²

= 7938

Phương pháp 2:

Chia cho số nguyên tố

2	882	1134
3	441	567
3	147	189
7	49	63
	7	9

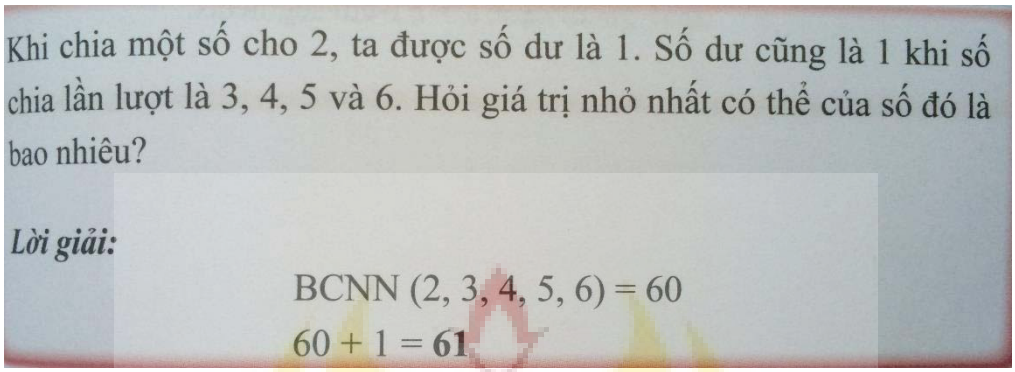
ƯCLN = 2 × 3 × 3 × 7

= **126**

BCNN = 2 × 3 × 3× 7 × 7 × 9

= **7938**

In that question, students must solving the problem about determine the GCD and LCM of 882 and 1134.


Khi chia một số cho 2, ta được số dư là 1. Số dư cũng là 1 khi số chia lần lượt là 3, 4, 5 và 6. Hỏi giá trị nhỏ nhất có thể của số đó là bao nhiêu?

Lời giải:

BCNN (2, 3, 4, 5, 6) = 60

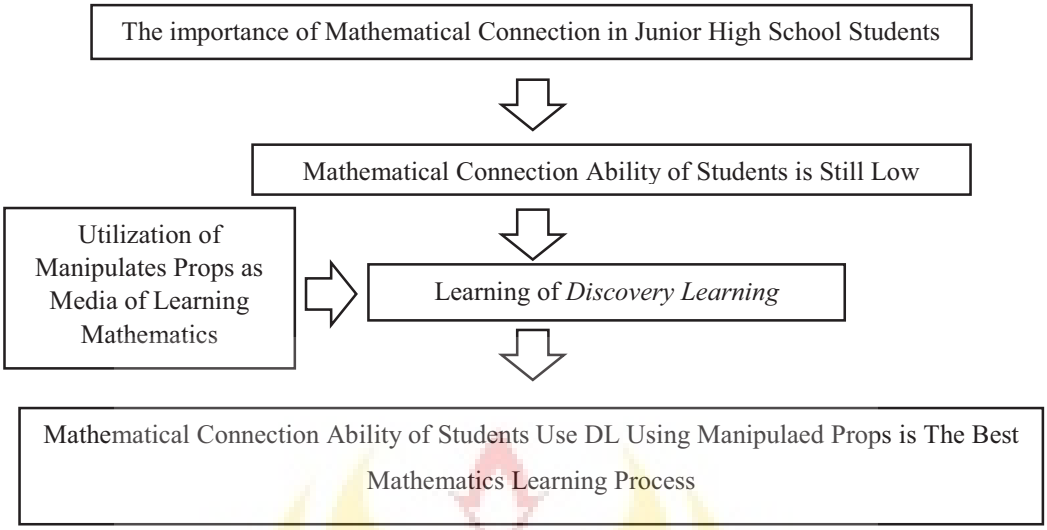
60 + 1 = **61**

The problem' mean is the remainder is 1 when a certain number is divided by 2. The remainder is also 1 when the Divisors are 3, 4, 5, and 6 respectively. What is the smallest possible of ths number? To solve this problem we are using the LCM concept.

2.5 Framework of Thinking

A good framework of thinking will explain theoretically about the linkage between the variables to be studied (Sugiyono, 2015). The linkage between these variables then will be formulated into study paradigms. Therefore, on every compilation of study paradigms must be based on a framework of thinking.

Based on theoretical studies, it is known that the mathematical connection is one of the foundation that can be used in preparation of students in dealing with problems, whether it's a problem in mathematics at school or problems in real life everyday. Importance of mathematical connections owned by each student is encouraging researcher to make analysis on the mathematical connection owned by junior high school students VI. Frame of thinking in this study described in Figure 2.2



Picture 2.2 Framework Thinking

2.6 Hypothesis

Based on the framework of thinking above, then the hypothesis in this study are.

1. Students mathematical connection ability who learn with *Discovery Learning* using manipulated props is reaching the mastery learning.
2. There is a difference the mathematical connection ability among students who learn Discovery Learning using manipulated props, students who learn Discovery Learning, and students who learn conventional learning in Vietnam, as follows.
   a. The mathematical connection ability of students who learn Discovery Learning using manipulated props is better than the mathematical connection ability of students who learn Discovery Learning.
   b. The mathematical connection ability of students who learn Discovery Learning using manipulated props is better than the mathematical connection ability of students who learn conventional learning in Vietnam.

c. The mathematical connection ability of students who learn Discovery Learning is better than the mathematical connection ability of students who learn conventional learning in Vietnam.

CHAPTER 5

CLOSING

5.1 Conclusion

According to the study result and discussion, we get conclusion that.

(1) The mathematical connection ability of students who learn with *Discovery Learning* using manipulated props is reach the mastery learning.

(2) There is a difference between the mathematical connection ability among students who learn Discovery Learning using manipulated props, students who learn Discovery Learning, and students who learn conventional learning in Vietnam, as follows.

a. The mathematical connection ability of students who learn Discovery Learning using manipulated props is better than the mathematical connection ability of students who learn Discovery Learning.

b. The mathematical connection ability of students who learn Discovery Learning using manipulated props is better than the mathematical connection ability of students who learn conventional learning in Vietnam.

c. The mathematical connection ability of students who learn Discovery Learning is better than the mathematical connection ability of students who learn conventional learning in Vietnam.

5.2 Suggestion

According to the study result, writer is giving the suggestion as follows.

(1) Mathematics learning with Discovery Learning using manipulated props can be implemented in mathematics learning of the mathematical connection ability on the material GCD and LCM.

(2) Teachers can apply Discovery Learning using manipulated props for students' mathematical connection ability on the othe mathematics material.

(3) Teachers in applying Discovery Learning using manipulated props always supervise students activites in the group discussion, So that students who have difficulty can directly ask, So that time is used more efficiently.

(4) Teachers in applying Discovery Learning using manipulated props manipulative should prepare props more because most students want to try using props by them self.

(5) Teachers that apply Discovery Learning should be create a group with the same capabilities average for each group.

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