THE EFFECTIVENESS OF STEM PROBLEM BASED LEARNING TOWARDS STUDENTS' PROBLEM SOLVING ABILITY AT PSS HANOI ON TRIANGLE COURSE

a final project

submitted in partial fulfillment of the requirements

for the degree of *Sarjana Pendidikan*

in Mathematics

by

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DECLARATION OF ORIGINALITY

I, Nurseto Dwi Nugroho hereby declare that this final project entitled *The Effectiveness of STEM Problem Based Learning Towards Students' Problem Solving Ability at PSS Hanoi on Triangle Course* 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 Information derived from the published and unpublished work of others has been acknowledged in the text and a list of references is given in the bibliography.

Semarang, 16 June 2017

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APPROVAL

This final project entitled

The Effectiveness of STEM Problem Based Learning Towards Students' Problem Solving Ability at PSS Hanoi on Triangle Course

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MOTTO AND DEDICATION

Forget safety. Live where you fear to live.

(Rumi)

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To my beloved Mom, Dad and my whole families.

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Nurseto Dwi Nugroho

ABSTRACT

Nugroho, Nurseto Dwi. 2017. *The Effectiveness of STEM Problem Based Learning Towards Students' Problem Solving Ability at PSS Hanoi on Triangle Course*. Final Project, Mathematics Department, Mathematics and Natural Sciences Faculty, Universitas Negeri Semarang. Main Advisor: Drs. Amin Suyitno, M.Pd, Companion Advisor: Drs. Mashuri, M.Si.

Keywords: Problem Based Learning, STEM, Problem Solving Ability

The Problem Solving Ability of the students at Pascal Secondary School, Hanoi, Vietnam is still at low level. Whereas, problem solving has received broad public interest as an important competency in modern societies. In this case, there is a need of using a model which facilitates the students to explore every problem by their own which is related with mathematics. The learning model which meets this criteria is STEM Problem Based Learning. The purposes of this research were: (1) to identify that the problem solving ability of the seventh grade students who are using STEM Problem Based Learning passed the mastery learning at PSS Hanoi and (2) to identify that the problem solving ability of the students who are using STEM Problem Based Learning is better than the one who are using Conventional learning model in Vietnam at PSS Hanoi.

Population of this research was all of the seventh grader students at Pascal Secondary School, Hanoi, Vietnam. By using Cluster Random Sampling technique, two classes were chosen as the sample of this research, they were 7A as the control class and 7B as the experiment class. The method of data collection used in this research were documentation and test method. The data was analyzed by One Side Proportion Test and Independent Sample T Test.

The result of this research shows that: (1) the students' problem solving ability using STEM Problem Based Learning passed the mastery learning at PSS Hanoi and (2) the students' problem solving ability using STEM Problem Based Learning was better than the one who were using Conventional learning model in Vietnam at PSS Hanoi.

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LIST OF ABBREVIATION AND ACRONYMS

MOET	Ministry of Education and Training
MPC	Minimum Passing Criteria
NCTM	National Council of Teachers of Mathematics
OECD	Organization for Economic Co-operation and Development
PBL	Problem Based Learning
PISA	Program for International Students Assesment
PSS	Pascal Secondary School
STEM	Science, Techonology, Engineering and Mathematics

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CHAPTER 1
INTRODUCTION

1.1 Background of the Research

Global Competitiveness is increasing by leaps and bounds along with the implementation of Asean Economic Community (AEC) that requires the need of professional human resources. One of the challenging problems to face is the development of the education. Education is the basic foundation that affects the quality of the major human resources of a country. The goals and qualities of an education will be seen from the vision and mission and also the strategy to achieve them which is reflected in the curriculum, syllabus, the availability of the human resources, education program, sources that available with the curriculum and that it should be updated (Zainal *et al*., 2014: 43). Conforming to the previous statements, the current learning activities need to follow the development of the global condition.

Baswendro (2015) stated that mathematics is the base from every knowledges which have the important role for human life aspects and for the development of another knowledges. Giganti (2007) mentioned that there are three parts of learning mathematics: skills, concepts, and problem solving. If we think of skills and concepts as what we need to know in mathematics, then problem-solving is the ability to apply mathematics we know in different situations. Problem Solving has received broad public interest as an important

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competency in modern societies (Greiff *et al*, 2013). Whereas, based on NCTM or National Council of Teachers of Mathematics (2000) problem solving is one of the process standards which describe what mathematics instruction should enable students to know and do. The five process standards are problem solving, reasoning and proof, communication, connections and representations.

This final project was intended as a research on a set of Mathematics lessons based on a certain kind of learning methods. The lessons were given to a beginner level learners in Vietnam: these were secondary students who have been taught Mathematics for six years or more. They did, however, know a bit of mathematics problem solving. They could, for instance, mouth the rules to solve mathematics problems.

All forms of education in Vietnam are handled by several ministries but since 1990, MOET (Ministry Of Education and Training/*Bo Giao Duc va Dao Tao*) take a full responsibility for all levels of education in Vietnam. MOET does such thing like submitting proposals for the founding of new schools to the National Assembly, creating and publishing new textbooks and curricula, merging existing education institutions, drawing up guidelines for the admission of students, and issuing certificates and diplomas. The main education goal in Vietnam is "improving people's general knowledge, training quality human resources, and nurturing and fostering talent".

Education in Vietnam is divided into five levels: Pre-school Education, Primary Education, Basic Secondary School, Secondary School and Higher Education/University Education. While the formal education consists of three

levels: 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 lasts for 5 years and compulsory for all children aged 6-11 years old. Secondary Education lasts for 4 years and compulsory for all teenage aged 11-15 years old. While the Secondary School Education and Secondary Vocational Education have the same level as what Indonesia has, they are the same as SMA and SMK. These levels last for 3 years and compulsory for all teenagers aged 16-18 years old. The Education System in Vietnam will be shown in the following figure.

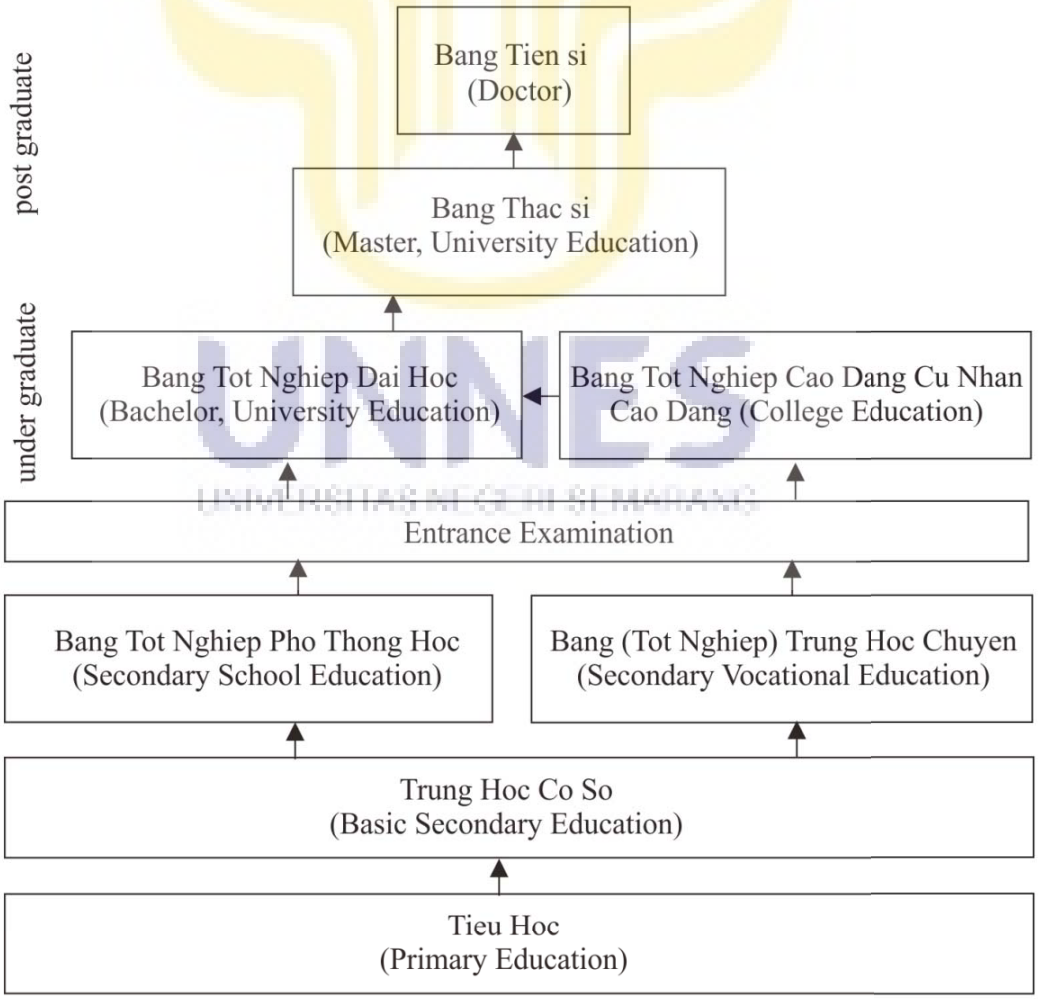

Figure 1.1 Education System in Vietnam

Vietnam National Assembly claimed that national education system of Vietnam consists of preschool education, basic education, vocational education, postgraduate, and graduate education. The basic education consists of primary, middle, and high education which is ilustrated in the following figure.

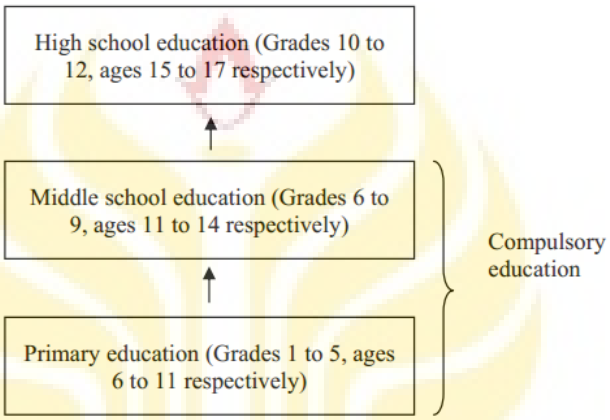

Figure 1.2 Basic Education System in Vietnam

Vietnamese curriculum is known as rigorous curriculum that is deemed as competitive for students. Secondary education becomes one of the most significant social issues in the country: designated schools known as "High schools for the gifted" (*Trường trung học phổ thông chuyên*) are considered as prestigious and often demand high entrance examination results. Higher education is also a fundamental cornerstone in Vietnamese society. Entrance to the university is determined through the Entrance Examination or usually called the National High School Graduation Examination as shown in the figure 1.1, whose results will be considered for evaluation. The higher the score is, the more prestigious the institution will be. Failure to attend the university often leads to

social stigma, as those who could not pass the Entrance Examination would be looked down upon by members of society.

According to Taplin in Setiawan (2014), the importance of problem solving can be reviewed from three values such as follows:

> (1) functionally, the problem solving is importance because the value of mathematics as an essential discipline can be developed through problem solving; (2) logically, problem solving helps the students to enhance the logical reasoning skill; (3) aesthetically, problem solving involves the emotion or affection of the students during the process of solving a problem.

The reform curriculum in Vietnam tries to lessen the training of basic skills and procedures in mathematics but increases more hands-on activities to help students grasp the mathematics ideas and develop mathematical thinking (Vui, 2007). While, the importance of the ability to solve mathematics problem in Vietnam was not in line with the rate of the students' problem solving ability. Claimed by the annual survey by Program for International Student Assesment (PISA) on 2015 by Organization for Economic Co-operation and Development (OECD), Vietnam ranked 22 from 72 participating countries in the scope of mathematics, which can be seen from the *Appendix 1*. The PISA 2015 survey focused on science, with reading, mathematics and collaborative problem solving as a minor areas of assesment. The things assessed by PISA were the ability of 15-years-old students of analyzing problem (analyze), formulating the problem (reasoning), and communicating the idea (communication) in any situation. The participants of the survey were 540.000 students representing 29 millions 15-year-olds students in the schools from 72 participating countries.

There have been many researches done about improving students' problem solving ability. Saputra (2015) mentioned some of the learning models which able to develop students' problem solving ability, they are Creative Problem Solving (CPS) and Problem Posing (PP). Both of the learning models emphasize on the exercises, especially the kind of non-routine exercises to enhance students' problem solving ability. Thus, the researcher wanted to try another model.

Based on the problems and the challenges, it is needed the using of better learning model than the previous model, conventional learning model in Vietnam which is an expository learning model. The learning model must be student-centered and directed the students to explore by theirself every problems connected with mathematics. One of the model that meets the criteria is Problem Based Learning (PBL).

PBL is an instructional and (and curricular) learner-centered that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develope a viable solution to a defined problems (Savery, 2006). That is, students must learn to be conscious of what information they already know about the problem, what information they need to know to solve the problem, and the strategies to use to solve the problem (Ross, 2001). Thus, the researcher assumed that PBL will enhance students' problem solving ability.

Education should be thaught by suitable approach to enhance or encourage students so they will be interested and engaged in the lesson in order to make them have a deep understanding about the lesson the learned. Integrating STEM

will be a crucial role in achieving this. The research by Dischino, *et al*., (2011) also shows that STEM PBL improved problem solving ability

> STEM education can be defined as an approach to teaching and learning everywhere between two or more in components STEM or between a component STEM which other disciplines ... which integrate mitigation thinking in teaching and learning of science education in schools. In general, integration of STEM education in teaching and learning should run at all levels of education, from primary school to university. This may be due to aspects of the implementation of such STEM intelligence, creativity, and design capabilities are not dependent on age (Sampurno *et al*, 2015: 74)

Some examples of mathematics problems on triangle course that suitable for enhancing students' Problem Solving Ability are:

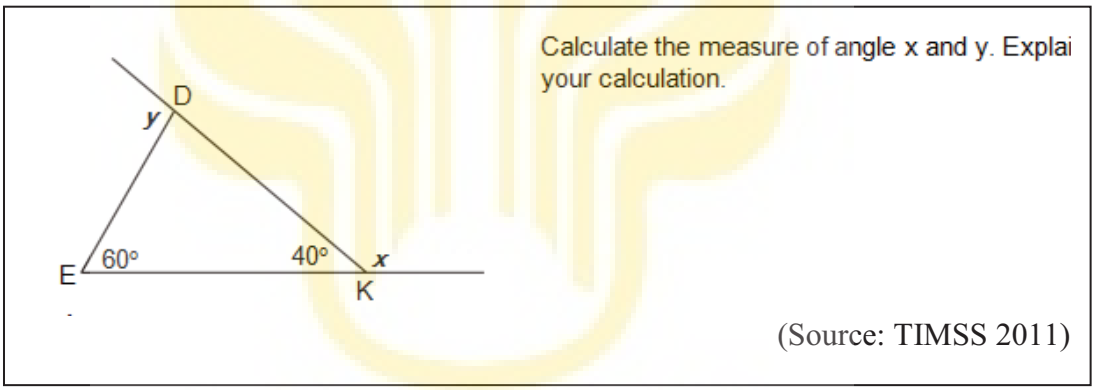

Figure 1.3 The Application of Exterior Angle of A Triangle

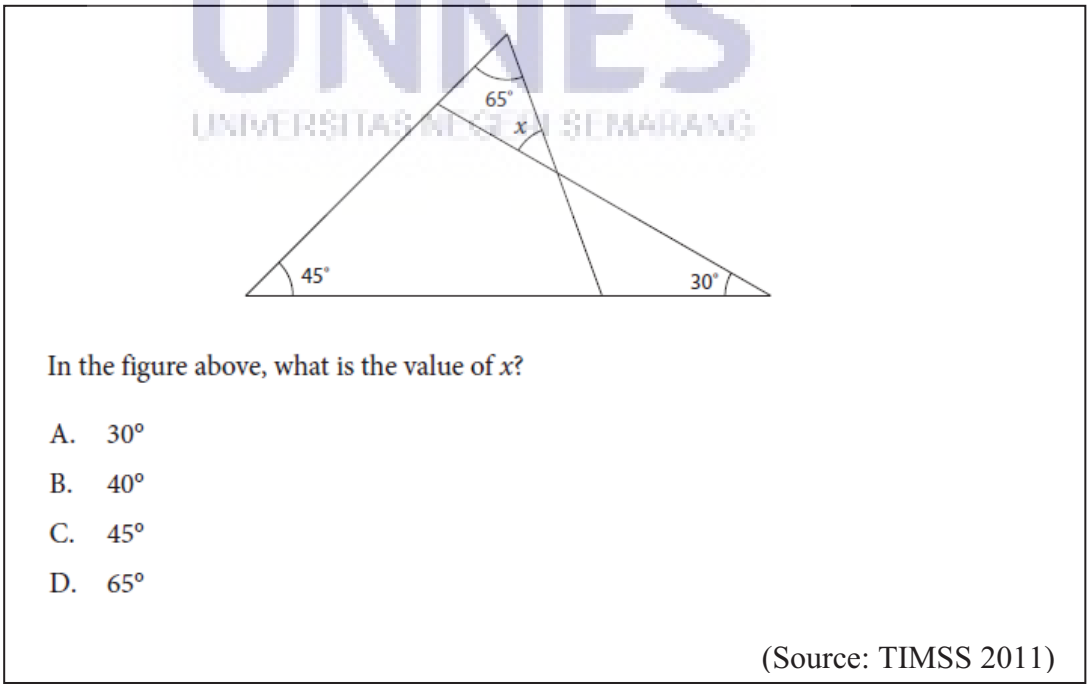

Figure 1.4 Another Application of Exterior Angle of A Triangle

The problems above involve both analytical and creative skills which enrich the students' Problem Solving Ability. The problems also conducted from Trends in International Mathematics and Science Study (TIMSS).

Based on the explanation above, the researcher decided to do a research under the title "**The Effectiveness of STEM Problem Based Learning Towards Students' Problem Solving Ability at PSS Hanoi on Triangle Course**".

1.2 Limitation of The Problem

The discussion of the research is limited on the following things.

1. the aspect measured in the research is the Problem Solving Ability of the students; and
2. the objects of the research are the seventh grade students of PSS Hanoi (Pascal Secondary School, Hanoi).

1.3 Research Problems

Based on the background, the research problems proposed in this research are as follows.

1. Does the students' Problem Solving Ability who are using STEM Problem Based Learning pass the Mastery learning at PSS Hanoi?
2. Is the students' Problem Solving Ability who are using STEM Problem Based Learning better than the one who are using Conventional learning model in Vietnam at PSS Hanoi?

1.4 Objectives of The Research

This research was intended to reach the purposes as follow.

1. To examine that the students' Problem Solving Ability who are using STEM Problem Based Learning pass the mastery learning at PSS Hanoi.
2. To examine that students' Problem Solving Ability who are using the STEM Problem Based Learning is better than the one who are using Conventional learning model at PSS Hanoi.

1.5 Significances of The Research

By conducting this research, the researcher hopes that:

1. Theoretically, especially for teachers, this research can provide broader understanding about how to conduct STEM Problem Based Learning for mathematics lessons in the school.
2. Practically, especially for the students, this research will be a bridge for the student to be able to experience integrated STEM learning which is not popular yet in Indonesia.
3. Pedagogically, the readers can make this research as a guidance in using STEM Problem Based Learning as an effective learning model for triangle course.

1.6 Definitions of Key Terms

In this research, there are five important key terms which need to be clearly defined. The definitions of key terms are written in order to equalize the point of

view and the interpretation of the title of the research. The definition of key terms are mentioned as follows.

1.6.1 Mastery learning

The success of learning happens when the students pass the Minimum Passing Criteria (MPC) which is a term that actually does not exist in Pascal Secondary School. Masrukan (2013) said that MPC is a number as a standard or minimum limit of students' ability so it can be said that they pass a competence or a subject. Based on the observations and interviews to the teachers in PSS Hanoi, if there is a student who gets a score less than 75 then he or she will be given an additional exercises that should be done for homework. Thus, the term "remidial" is to get more exercises. At PSS Hanoi, based on the interview with the mathematics' teacher for grade 7, a class is passing the mastery learning if the percentage of the students which pass the MPC is more than 75% compared to the sum of the students in that class. In this research, the MPC used is 75. Therefore, if there is a student who gets the score which is more than or equal to 75, it can be said that the student pass the MPC.

1.6.2 Problem Based Learning

Savery (2006) has defined Problem Based Learning or abbreviated as PBL as an instructional (or curricular) learner centered approach that empowers learners to conduct a research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem. The steps of PBL are as follows: (1) Orient the students into the problem, (2) Organize the students to

study, (3) Assist with independent or group investigation, (4) Develop and present artifact and exhibits, (5) Analyze and evaluate the works.

1.6.3 Problem Solving Ability

Xie (2004) said that the problem solving ability is the main goal of mathematics education which contains both intellectual and non-intellectual aspects. The steps of solving a problem based on Polya (1957) are: (a) understand the problem, (b) devise a plan, (c) carry out the plan, (d) looking back to the solutions. Chotimah in (Mawaddah & Anisah, 2015) said that the indicators of problem solving ability such as the following: (a) the ability to show the problem understanding, (b) the ability to create or arrange mathematics model, (c) the ability to eliminate and develop problem solving ability strategy, (d) the ability to explain and check the validity of the answer obtained.

1.6.4 Science, Technology, Engineering and Mathematics (STEM)

Doheny in Barth (2013) stated that the term "STEM," is an acronym for Science, Technology, Engineering, and Mathematics, is credited to Judith A. Ramaley, former assistant director of the National Science Foundation. While Kementrian Pendidikan Malaysia (2016) defined STEM as a teaching and learning approach that involves the application of knowledge, STEM skills and values to solve problems in the real life context, society and the environment as shown in the figure 1.5 below.

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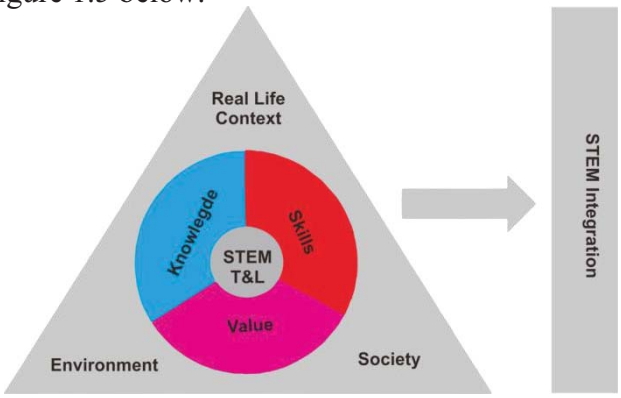

This approach encourages the students to ask questions and explore the

Figure 1.5 STEM as A Teaching and Learning Approach

towards integrating STEM practices.

1.7 Outline of the Report

This research is divided into five chapters as follows:

1. Chapter 1 introduces the general background of the research, limitation of the problem, research problems, objectives of the research, significances of the research, definition of key terms and outline of the report.
2. Chapter 2 presents the literature review consisting of review of the previous research, the theoritical reviews and the theoretical framework.
3. Chapter 3 discusses about the method of investigation. It includes research design, method of subject determination, method of data collection, research activities, research instrument, validity and realibility of the instrument, initial data analysis, and final data analysis.
4. Chapter 4 covers the result of the research. It presents the research finding and discussion about the result analysis.
5. Chapter 5 gives the conclusions and suggestions for the future research.

CHAPTER 2
LITERATURE REVIEW

2.1 Problem Solving Ability

Xie (2004) said that the problem solving ability is the main goal of mathematics education which contains both intellectual and non-intellectual aspects. Intellectual aspect included here are such as the following contents: the ability to formulate, pose and investigate mathematics problems; the ability to collect, organize and analyze problems from mathematical perspective; the ability to seek proper strategies; the ability to apply learned knowledge and skills; and the ability to reflect and monitor mathematical thinking process. The non-intellectual aspect included here are the cultivation of positive dispositions, such as persistence, curiosity and confidence, the understanding of the role of mathematics in reality, and the tendency to explore new knowledge from mathematics perspective.

2.1.1 Mathematical Problem Solving

Bell in Kurniawan (2015) said that mathematical problem solving is the resolution of a situation in mathematics which is regarded as a problem by the person who resolve it. Institute of Education Sciences (2012) emphasizes that students who develop proficiency in mathematical problem solving early are better prepared for advanced mathematics and other complex problem-solving tasks. A situation is said to be a problem if they realize if there is a problem in the

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situation, knowing that the problem can be solved. Problem solving can be said as a way to find the new way to solve a problem.

2.1.2 Polya's Problem Solving Technique

The steps of solving a problem based on Polya (1957) are: (a) understand the problem, (b) devise a plan, (c) carry out the plan, (d) looking back solutions. According to Alfred in this quoted by Kurniawan (2015), there are 10 strategies to solve a mathematics problem, they are:

a. Working backward

   This strategy can be used if the problem solver knows how to solve the problem to the end point but there too many ways that used to solve a problem from the start point.

b. Looking for the pattern

   In mathematics, we have logic and orderliness.

c. Adopting different point of view

   In solving a problem we might find the solution directly, but the solution is the effective way. Therefore, it is advantageous to solve a problem from our different point of view.

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d. Solving with simpler analogy

   In solving a mathematics problem sometimes we found a difficulty to solve it. That is why we need to simplify the exercise given into a simpler form so it is easier to be understood and solved.

e. Looking at extrem case

To solve an extrem problem sometimes we need to change a variable to make it easier but what we change is something that does not change the initial problem.

f. Making the sketch (Problem Visualization)

Visualization is used as a facilitator to solve a problem rather than as elements of the problem.

g. A nice guess and testing

In this strategy, we have to make a guess and apply it to the exercise. This model is quiet different with trial-and-error because there is a barrier for the value of the variable focused on the final answer. In this model, the answer will be seen in order.

h. Count all the possibilities

The strategy usually called “Eliminating/Eliminate any possibility” that is a strategy where the problem solver eliminate some possible answers until they get the right answer left.

i. Organize data

Reorganize the data given can be an alternative in order to see a problem.

j. Logic reasoning

This depends on how often we do exercises.

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2.1.3 Indicators of Problem Solving Ability

According to Chotimah which is quoted by Mawaddah & Anisah (2015), mathematics Problem Solving Ability indicators are as follows:

1. **Able to show the problem understanding**, including the ability to identify the informations given, asked, and the elements needed to solve a problem.
2. **Able to create or arrange mathematics model**, including the ability to formulate a real world mathematics problem.
3. **able to eliminate and develop Problem Solving Ability strategy**, including the ability to outline any possibilities or, for instance, the ability to find the best way to choose the precise formula or previous knowledge to be used in solving a problem.
4. **able to explain and check the validity of the answer obtained**, including the ability to identify the errors of calculation, the missapplication of formula(s), check the compatibility between what is found and what is asked, and able to explain the validity of the answer.

2.2 Science, Technology Engineering and Mathematics (STEM)

The term "STEM," is an acronym for Science, Technology, Engineering, and Mathematics. Kementrian Pendidikan Malaysia (2016) defined STEM as a teaching and learning approach that involves the application of knowledge, STEM skills and values to solve problems in the real life context, society and the environment as shown in the figure 2.1 below.

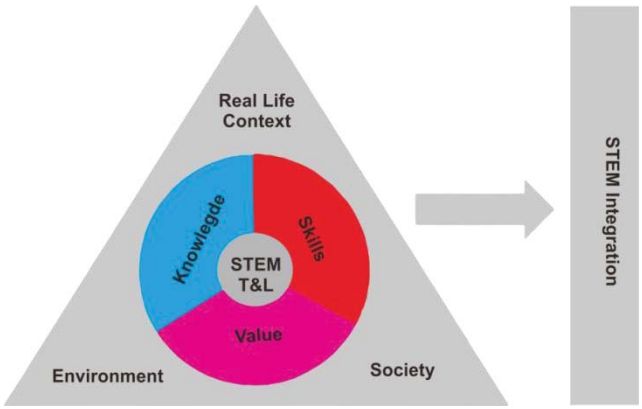

Figure 2.1 STEM as A Teaching and Learning Approach

2.2.1 STEM Elements in The Curriculum

2.2.1.1 STEM Knowledge

The STEM Knowledge is an idea, concept, principle, theory and understanding in the STEM fields which is formulated in the curriculum of all STEM subjects. The curriculum that has been arranged and designed aims to give the knowledge to the students, skills and sufficient values through the activity provided by the teacher both in and out of the classroom during the teaching and learning process. The process of getting the knowledge of STEM progressively and dynamically is really important in order to make the student achieving current STEM knowledge.

2.2.1.2 STEM Skills

STEM Skills are the proficiency and competence to explore, solve problems, designing and producing. These skills can be obtained through the activities, project or assignments that has been arranged in the curriculum of all STEM subjects. STEM skills consist of process skill and technical skill. Process skill used in the process of learning and the process of applying knowledge to solving a problem. Process skills involve the science process skill, mathematical process skill, design skill, and computational thinking skill. Technical skills are

involving psychomotor skills that include manipulative skill, management skill, the skill of handling materials, tools, and machines in a proper way.

2.2.1.3 STEM Value

Values and ethics of STEM is a positive character or moral and the guidelines that should be obeyed by the students. The implementation of values and ethics of STEM during the teaching and learning process is important in producing students who are not only knowledgeable and competent, but have a high personality. The values emphasized here are systematic, objective, consistent, rational, though, commited, curious, dare to try, open-minded, inovatice, et cetera. While the examples of the ethics that should be obeyed by the students are lab rules, workshop regulations and safety guideline.

2.2.2 The Characteristics of STEM Learning

According to Kementrian Pendidikan Malaysia (2016), there are 7 characteristics of STEM teaching and learning for guiding the teachers in applying STEM teaching and learning in the school. The characteristics mentioned as follows.

1. engage the students in the inquiry and open exploration;
2. engage the students in productive teamwork;
3. requires the students to apply their understanding of STEM contents;
4. provide the opportunity to the students to improve answer and products;
5. involve the students to apply design process skills;
6. requires the students to give multiple answers or solutions with its justification; and

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7. enhance students' sense to the real-world issues and problems.

This approach encourages the students to ask questions and explore the environment through inquiry and resolve problems related to the real world towards integrating STEM practices. This new discipline was meant to transform traditional classrooms from teacher-centered instruction into inquiry-based, problem solving, discovery zones where children engage with content to find solutions to problems. Morrison (2006) described several characteristics of STEM education for students, schools, and classrooms. The STEM educated student is a problem solver, logical thinker, technologically literate, and able to relate his (or her) own culture to the learning. The STEM school has STEM literacy as a priority and culturally relevant to all students, has curriculum materials in support of the STEM instruction, fosters a culture of questioning and creativity, and encourages assessment practices that are both formative and performance based. The STEM classrooms, grades 6 through 12, are active and student-centered, has computers with STEM software, has easily reconfigurable furniture, and serves students with various learning styles as well as those with disabilities.

Integrating STEM in a learning program means that the learning combines two or more elements in STEM- Science, Technology, Engineering, and Mathematics. The focus about STEM learning is involving students to define and formulate a solution to authentic real-world problems. The table below shows us the literacy definition of STEM based on National Governor's Association Centers for Best Practices.

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Table 2.1 STEM Literacy Definitions

Science	the ability to use scientific knowledge (in physics, chemistry, biological sciences, and earth/space sciences) and processes to understand the natural world but to participate in decisions that affect it (in three main areas — science in life and health, science in Earth and environment, and science in technology)
Technology	in the modern world means the ability to use, manage, understand, and assess technology. Students should know how to use new technologies, understand how new technologies are developed, and have skills to analyze how new technologies affect us, our nation, and the world. Technology is the innovation, change, or modification of the natural environment to satisfy perceived human needs and wants.
Engineering	is the understanding of how technologies are developed via the engineering design process; lessons are project-based and integrate multiple subjects, making difficult concepts relevant and tangible to students and tapping into students' natural interest in problem-solving. Engineering design is the systematic and creative application of scientific and mathematic principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.
Mathematics	means the ability of students to analyze, reason, and communicate ideas effectively as they pose, formulate, solve, and interpret solutions to mathematical problems in a variety of situations.

In Problem Based Learning designed in the research, the integration of STEM used are Technology, Engineering and Mathematics. The technology used in the research was the using of presentation. The engineering topic used building

construction design. And in mathematics field the researcher used triangle as the material.

2.2.3 The Example of STEM Lesson Activity

Kementrian Pendidikan Malaysia (2016) gives an example of STEM Lesson Activity as follows.

Table 2.2 Example of Malaysian STEM Lesson Activity

Cadangan Aktiviti	Catatan
Seorang ahli perniagaan ingin membina sebuah rumah baharu. Beliau telah mengiklankan dalam surat khabar tawaran tender bagi rekaan lantai rumah baharunya. Syarikat anda berminat dan bercadang untuk menghantar tender bagi projek ini. Anda selaku pengurus projek perlu membentuk satu pasukan kerja. Pasukan kerja anda harus terdiri daripada seorang pereka, seorang akauntan, seorang jurutera binaan dan beberapa orang profesional. Keluasan lantai bagi rumah baharu itu adalah 150 m2 yang terdiri daripada sebuah ruang tamu, dua bilik tidur, sebuah dapur dan sebuah bilik air. Tugas pasukan anda adalah untuk menghasilkan pelan lantai bagi rumah tersebut. Anda harus mengambil kira saiz dan susun atur setiap bilik yang menepati keluasan yang diberi. Berdasarkan pelan lantai yang dihasilkan, reka corak lantai dan susunan jubin yang bersesuaian bagi setiap ruang/ bilik dengan kos anggaran. Kemasan lantai bagi setiap ruang/ bilik akan menggunakan jubin seramik yang berlainan jenis dan saiz. Kos adalah salah satu faktor utama yang harus dipertimbangkan dalam pemilihan bahan binaan yang akan digunakan. Syarikat yang mengemukakan rekaan yang menarik dengan bajet yang berpatutan akan mendapat tender tersebut. Fikirkan strategi terbaik untuk mengemukakan kedua-dua reka atur pelan lantai dan anggaran kos. Selamat maju jaya.	**Sumber:** 1. Buku teks tingkatan 1, 2 dan 3. 2. Buku rujukan, majalah. 3. Laman sesawang: http://binarumah.com/belajar-autocad/, http://binarumahsendiri.blogspot.my/2011/10/pelanrumah.html. 4. Modul/ Risalah. 5. Pakar binaan dan reka bentuk pelan

Garis panduan menjalankan aktiviti :

1. Murid membentuk kumpulan;
2. Murid perlu membawa set geometri dan peralatan lain untuk melukis;
3. Guru perlu membawa pita ukur yang mungkin berguna semasa pembelajaran;
4. Murid perlu membentangkan pelan lantai dan bajet kepada rakan sekelas;
5. Semasa pembentangan murid perlu membuat penilaian kendiri dan juga ahli; dan
6. Guru perlu menilai dan mentaksir setiap pembentangan projek.

Elemen STEM yang berkaitan:

Kandungan	Proses Pemikiran	Kemahiran	Nilai
- Poligon - Panjang, lebar, perimeter dan luas poligon - Lukisan berskala - Ukuran asas (panjang dan luas) - Perpuluhan	-Memilih skala yang sesuai - Membentuk dan mengaplikasi rumus matematik - Menetapkan kos yang minima bagi keseluruhan projek - Mengaplikasi konsep matematik	- Menyelesai masalah - Menganggar panjang dan luas - Menggunakan teknologidigital - Melukis pelan menggunakan skala - TMK - Komunikasi	- Membuat perkaitan dengan kehidupan sebenar - Berkolaborasi untuk menyelesaikan masalah - Menjana idea - Menghayati matematik

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2.3 Learning Theories

Learning is an experience to get and synthesize informations by the students. The students who understand and able to applicate the knowledge they have learned, need to be able to solve problems, find something new for themself and dealing with any ideas. Teacher is not the person who gives the knowledge to

their students, because the students must construct the knowledge in their own memory by themself.

Some theories which review the concept of learning have been developed by the experts. The theories that support this research are explained as follows.

2.3.1 Learning Theory by Bruner

Jerome Bruner was one of the most important psychologists of the 20th century, though it is in the field of education that his influence has been most keenly felt. Two of his books, *The Process of Education* and *Towards a Theory of Instruction*, have come to be recognized as landmark works and reveal Bruner's particular view of the educational theory known as constructivism.

Bruner (Trianto, 2007) suggested that students should learn through active participation with the concepts and principles, so that they are encouraged to gain experience, and do experiments which allowed them to discover the principle itself. Learning with the invention has several advantages among others, stimulate the curiosity of students, motivating them to continue its work so that they find the answers, and learn solving problems independently and practice critical thinking skills. It happens, because they must always analyze and manipulate the informations.

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Bruner's theory supports this research related to the problem based learning because it emphasizes active student involvement and student find or construct their own knowledge. It is appropriate Bruner statement (Trianto, 2007) which suggested that the students should learn through active participation with the concepts and the principles that they are encouraged to gain experience, and

conducting experiments that allow them to discovered the principle itself. At the stage of identification of problem, students analyze the problems they face and at the stage of data processing, students will manipulate the data that has been obtained in the previous stage the data collection phase. Analyze and manipulate the data is wrong one indicator advantage of learning by discovery that train skills critical thinking.

2.3.2 Learning Theory by Piaget

Based on Piaget's theory (Kemendikbud, 2013), related to learning the establishment and development of the scheme (plural schemata). Schemes ie is generally the existing potential in individuals to perform group specific behavior. Schemes never stops changing. Schemata a child will develop into the schemata of adults. Process cause changes in schemata is called adaptation. The process of forming this adaptation can be done in two ways, namely assimilation and accommodation.

Cognitive structures within each individual there is always a balance between assimilation with the accommodation. This meant that the balance can be detect similarities and differences contained in the stimulus – stimulus faced. Cognitive development is basically a change of the balance that has been held to a new balance obtained (Suherman, 2003).

Based on his research, Piaget (Suherman, 2003) suggested that there are four stages of cognitive development of each individual develops chronologically (according to calendar age) in example.

a. Sensory stage motors, from birth until the age of about 2 years. Children who are at this stage, the experience gained through physical actions (movements of limbs) and sensory actions (coordinates the senses). He/She began able to toss a physical object into symbols, for example began to speak imitate the sound of a vehicle.

b. Preoperative phase, from about the age 2 years up to about age 7 year. This stage is the stage of preparation for organizing concrete operations. At this stage the child's thinking more based upon concrete experiences rather than logical thinking, so when he/she saw the objects which looks different, then he/she said it differently.

c. Concrete operations phase, from about the age of 7 years up to about age 11 years old. Kids at this stage able to bind new definitions that have been there and express it back, but have not been able to formulate its own definition - the definition appropriately. They have not been able master verbal symbols and ideas - abstract idea.

d. The stage of formal operations, from about the age of 11 years onwards. Kids at this stage able to perform reasoning using abstract things. Kids in formal operation is no longer associated with whether there is any concrete objects, but dealing with this type of thinking. Whether the situation is accompanied by concrete objects or not, for children at the stage of formal thinking is not a problem.

Piaget's theory supports research related to STEM ingetration. Reasoning is one step scientific approach, it is appropriate the fourth stage of cognitive

development that is the stage of formal operations. At this stage, children are able to perform reasoning using things - abstract. Besides formal operations stage children - children from about age 11 years and beyond. This is according to a population which is the object research that junior high school students grade 7 where they were about 12 years of age.

2.3.3 Learning Theory by Dienes

Dienes learning theory emphasizes on the stages of the game means learning directed to a process that involves students in study. This means that the learning process can generate and make students happy to learn. Mathematics learning system of Dienes focused to manipulate concrete objects and games. If many forms given that different in certain concepts, will be more clearly for students to understood the concepts.

Zoltan Dienes' principles of mathematical learning have been an integral part of mathematics education literature and applied both to the teaching and learning of mathematics as well as research on processes such as abstraction and generalization of mathematical structures (Sriraman & English, 2005). The development of mathematical concepts by Dienes can be achieved through continuous pattern, namely the existence of a series of activities to learn from concrete to Symbolic. Phase learning is interaction planned between segments of the structure of knowledge and active learning, which conducted through the medium of mathematics specially designed. Concrete objects in the form of the game has a very important role in learning math if manipulated properly.

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Dienes (2000) argues that there are a six steps learning and teach mathematical concepts. The stages are:

1. Games Free (Free Play)

   According to the Post and Reys this first stage, the child is given the freedom to interact with the environment. Freedom in a sense, learning activities the initial stage is done by giving flexibility to the students to know, attention, identify all forms of games or objects concrete supplied in learning.

2. Using the game rules (Games)

   The second stage of learning with dienes theoretical approach, students are guided to build the abstract structure in the form of the game in terms This approach to the game is done by using the same method as students playing with their play equipment. As a game, then at this stage given the rules before it starts and some of the criteria that must be achieved so that it can be categorized The game goal is reached. Dienes directed at the stage This should be fun so that students in carrying out activities learning, students can easily shape the experiences knowledge.

3. Study equal nature (Searching for communalities)

   After passing through the stage of free play and games next learning stage are teachers lead students in finding similarities in the nature of various concrete objects or the game in learning. This stage also can be defined as an activity to look for isomorphisms. That is, in

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in a game that presents various forms of concrete objects and games, activities students are directed to compare different results which can be obtained. Dienes explained that the process of abstraction mathematics occurred after students running a play activity.

4. Representation (Representation)

Post and Reys stated that the representation of a fourth stage Dienes that learning the theory give freedom to the students to express a method or a way to represent all activity games that have similar structures. freedom of expression students can be realized in the form of both visual and audio. Form suppose is a visual representation of images, numbers, or numbers, graphics. The term representation is described by Dienes representation obtained from a concrete activity or a part of the game depiction is made to direct students to the notion abstract mathematical structures that are contained in the draft being studied.

5. Games with symbolization (Symbolization)

After the stage of representation, the learning phase is followed by the next student changing representations to a symbol - a symbol. this stage dikarakterisikkan as the investigation of the properties - properties that are identified at stage 4. The symbolization including learning phase concept requires the ability to formulate a representation of each concepts using mathematical symbols or through formulation verbal.

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6. Games with formalization (formalization)

The formalization of the concepts of the last stage of learning. In this phase the nature of the system is ready to be identified through the learning process for generating a theorem (statement of logical conclusions) on the system of an axiom (the rules of the game or the simple truth). as stage the end of the lesson, students are expected to understand the concept mathematical abstract of fun activities in presented original form of the game or of objects concrete known to them because the circuit component containing mathematical formulas representations of concepts circumference and area Flat (triangles and rectangles).

2.4 Problem Based Learning

2.4.1 The Definition of Problem Based Learning

Problem Based Learning or abbreviated as PBL is an instructional (and curricular) learner centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem (Savery, 2006). PBL as a method of learning which involves student centered learning in a small group lead by a tutor, rather than the teaching by lecturing method. Armstrong (2011) explain that the tutor's role is to be a facilitator for students to discover their own answer rather than to simply provide the correct answer. Students are expected to be able to organize their lives, studies and learning in a manner which prepares them for their chosen profession.

Duch, Groh, and Allen in Savery (2006) described the methods used in PBL and the specific skills developed, including the ability to think critically, analyze and solve complex, real-world problems, to find, evaluate, and use appropriate learning resources; to work cooperatively, to demonstrate effective communication skills, and to use content knowledge and intellectual skills to become continual learners.

2.4.2 Syntax of Problem Based Learning

Based on Arends (2008), the implementation of Problem Based Learning conists of 5 main steps which started where the teacher introduce the students to a problem and ends by the presentation and the product of the students.

Table 2.3 Syntax of Problem Based Learning

Steps	**Activities of Teacher and Students**
Step 1 Orient the students into the problem	The teacher define the learning goals and all the tools needed. The teacher motivates the students to be actively involved in the problem solving activity chosen.
Step 2 Organize the students to study	The teacher helps the students to define and organise the tasks related to the oriented problem in prior step.
Step 3 Assist with independent or group investigation.	Teacher encourages the students to collect suitable information and execute the experiments to get the things needed for solving the problem.
Step 4 Develop and present artifact and exhibits	Teacher helps the students to share their assignments and planning or preparing the work which is related to the result of the problem solving in a form of report, video or a model.
Step 5 Analyze and evaluate the works	Teacher helps the students to do reflection or evaluation according to the problem solving process.

2.4.3 Syntax of STEM Problem Based Learning

Syntax of STEM Problem Based Learning in this research looks like the syntax of Problem Based Learning, but the lessons are integrated by STEM elements. The syntax given in the following table.

Table 2.4 Syntax of STEM Problem Based Learning

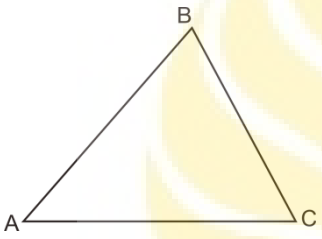
Steps	Activities of Teacher and Students	STEM Integration
Step 1 Orient the students into the problem	The teacher define the learning goals and all the tools needed. The teacher motivates the students to be actively involved in the problem solving activity chosen.	Integrating one or more of STEM elements (Science, Technology, Engineering and/or Mathematics
Step 2 Organize the students to study	The teacher helps the students to define and organise the tasks related to the oriented problem in prior step.	
Step 3 Assist with independent or group investigation.	Teacher encourages the students to collect suitable information and execute the experiments to get the things needed for solving the problem.	
Step 4 Develop and present artifact and exhibits	Teacher helps the students to share their assignments and planning or preparing the work which is related to the result of the problem solving in a form of report, video or a model.	
Step 5 Analyze and evaluate the works	Teacher helps the students to do reflection or evaluation according to the problem solving process.	

2.5 Materials Overview of Triangle

Two triangles can vary in size and shape, but the sum of three angles of this triangle is always equal to the sum of three angles of the other.

2.5.1 The Sum of Three Angles in A Triangle

Draw any two triangles, using a protractor to measure the three angles of each triangle and calculate the sum of three angles of each triangle.



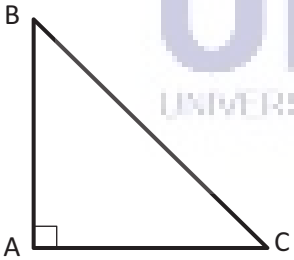
The sum of all angles in the triangle on the left side is $\hat{A} + \hat{B} + \hat{C} = 180^o$.

Figure 2.2 An Acute Triangle

The Sum of three angles in a triangle is 180^o

2.5.2 Applying to Right Angle

Definition: Right triangle is a triangle having one right angle.



In figure, given a triangle ABC with $\angle A = 90^o$. It is said that triangle ABC is right at A. AB and AC are called legs; BC is called hypotenuse.

Figure 2.3 A Right Triangle

In a right triangle, two acute angles are complementary

$\Delta ABC, \angle A = 90^o \rightarrow \angle B + \angle C = 90^o$.

2.5.3 Exterior Angle of A Triangle

Definition: An exterior angle of a triangle forms a linear pair with the adjacent interior angle of that triangle.

Each exterior angle of a triangle is equal to the sum of its two non-adjacent interior angles.

2.6 Thinking Framework

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 Problem Solving Ability is the main foundation in preparing students in solvingproblems, whether it's a problem in mathematics at school or problems in everyday's real life. Importance of Problem Solving Ability owned by each student is encouraging researcher to do the research of enhancing students' Problem Solving Ability at secondary school grade 7. The thinking framework in this study described in the following Figure 2.4.

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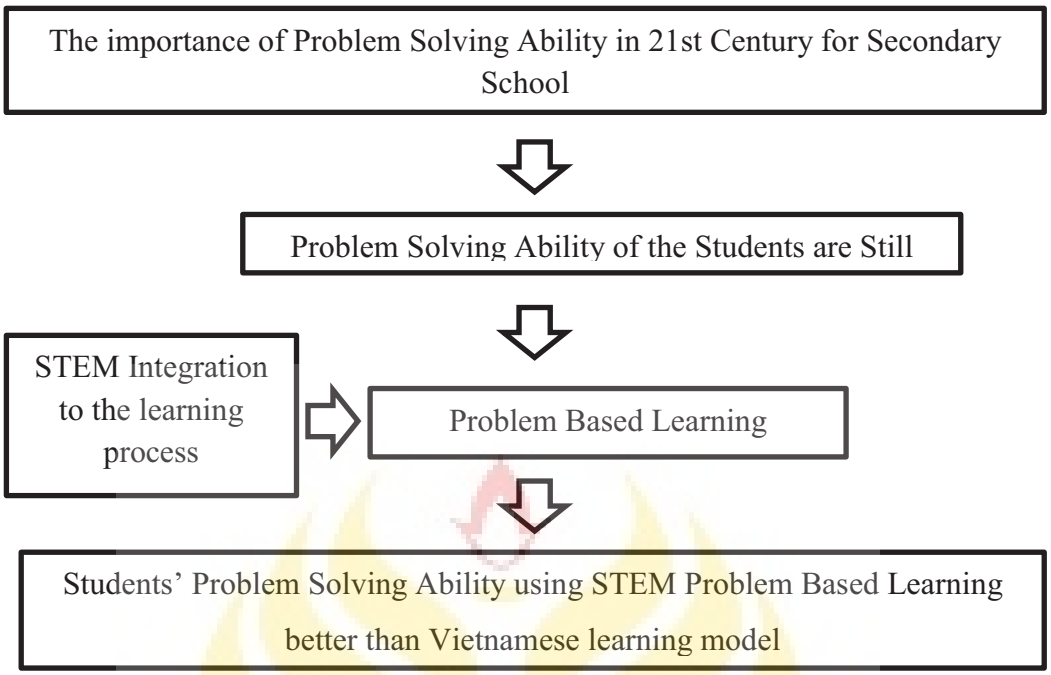

Figure 2.4 Thinking Framework

2.7 Hypotheses

Based on the thinking framework above, then the hypotheses in this research are:

1. The Students' problem solving ability using STEM Problem Based Learning pass the Mastery learning.
2. The students' problem solving ability who are using STEM Problem Based Learning is better than the one who are using Conventional learning model in Vietnam at PSS Hanoi.

learning; (b) problem solving can stimulate the ability if the students to discover new knowledge for them; (c) problem solving can enhance the learning acitivity of the students; (d) problem solving helps the students to apply their knowledge in their daily life problems; (e) problem solving helps the students to develop their knowledge and to be used for their own evaluation regarding the learning process; (f) problem solving helps the students to practice to thik in facing a problem; (g) problem solving seems to be fun and being students' favorite; (h) problem solving develops students'critical thinking and the ability to adapt to new knowledge (i) problem solving gives the chances to apply their knowledge to the daily life problems; (j) problem solving develops the interest of learning of the students. Therefore, by using STEM Problem Based Learning, students will have a bigger opportunity to train and improve their Problem Solving Ability. In addition, because the learning is using group discussions, the students will exchange ideas to solve the problems. Whereas the Vietnemese learning model is using teacher-centered learning. (2) the experiment class in this study used STEM Problem Based Learning under a group discussion teamwork, the STEM learning helps the students in finding the concept the sum of three angles in a triangle and the exterior angle of a triangle, By integrating the elements of STEM, the learning process became more fun and unstressed.

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CHAPTER 5
CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

This is the last chapter of my final project. It presents the conclusions derived from the whole analyses and discussion presented in the previous chapter. It also provides suggestions based on the research findings.

Based on the research results and discussion, the conclusions obtained were:

1. The students' problem solving ability using STEM Problem Based Learning passed the mastery learning at PSS Hanoi.
2. The students' problem solving ability using STEM Problem Based Learning was better than the one using Conventional learning model in Vietnam at PSS Hanoi.

5.2 Suggestions

Suggestions dealing with this research were addressed to the readers, the next researchers, the analyst and the teachers. The suggestions were as follows:

1. Mathematics students should improve their problem solving ability. To respond these need, teachers should have a deeper understanding about conducting STEM integrated learning.
2. Mathematics teachers should implement the mathematics learning using STEM Problem Based Learning in the lessons in order to enhance problem solving ability on triangle course.

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3. Mathematics teachers should implement the STEM Problem Based Learning in order to enhance students' problem solving ability in another mathematics materials that has the same characteristic with triangle course.
4. Mathematics teachers should do further research of using STEM Problem Based Learning in another material.
5. Mathematics teachers should monitor the students while they are doing a discussion in a group in order to make the lesson using STEM Problem Based Learning to be more efficient so that they can be more critical to identify problems and actively ask questions.

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