CHAPTER I
INTRODUCTION

1.1 Background

Most of us depend on the technology that exist in our daily life. Today we buy some food, clothes or even gadget by using technology. Technology is exist in every aspect in our daily life. We can make the hardest thing become easier. Now, the problem that can be found in every technology tend to give disadvantages. Eventhough there're some disadvantages and also lackness in the technology itself, but the advantages of technology is many more than the disadvantages of the technology. Therefore, researchers are always trying to invent and develop new better technologies in daily life (Quang, et al., 2015).

Technology is the application of scientific knowledge for practical purposes, especially in industry. One example way to support the development of the technology is by integrating the use of technology and build the technology with the learning process in the form of STEM (science, technology, engineering, mathematic) Learning approach. By using STEM learning approach, the competencies of high-tech knowledge-based economy can be done in the classroom (Quang, et al., 2015). The focused of the STEM Learning itself is focus on the development of the student interest in STEM careers for young learners (Jang, 2016). According to the Hasella's research result in (Manupil, Ismanto, & Onibala, 2015) from 41 respondent, 18 people are use gadget more than 11 hours a day. This show us that the use of technology by teenager is quite high. However, Hasella also states that most of them use it to acces the socialmedia like facebook, path,twitter, etc. Then (Manupil, Ismanto, & Onibala, 2015) also done the research about the affect of using gadget in student achievement. Then the result says that student who use technology (in this cases are gadget), have lower achivement than others. This is ironic, remembering how technology is something which interesting for some people. This is the reason why the researcher choose STEM learning as the approach to improve students' STEM literacy. STEM Literacy consist of 4 aspect that has been included 21st century skills into the 4 STEM literacy aspect itself (Quang, et.al , 2015).

STEM is one example of integrated approach. STEM content areas are mixed and learned as one subject (Quang, Nguyen, 2015). STEM should increase students' understading and also the skill to work and improve their use of technologies (Bybee, 2014). Besides, STEM also should be more introduced student to the engineering during precollage (Bybee, 2014). Engineering asked student to directly involve in solving a problem. Student are asked to learn by engineering model and design the solution of the problem whether the solution is in the form design of building or a project or the idea to solve the problem. Accoding to Jolly (2014) There are 6 characteristic of STEM Learning. (1) The focus of STEM learning must be on the real world problems and issues. (2) Engineering design process is the guide of STEM learning. (3) STEM learning must consist of hands-on inquiry and open-ended exploration. (4) Involve students to productive teamwork. (5) STEM learning apply an exact math and science content based on students learning. (6) STEM learning allow for multiple right answers and reframe failure as a necessary part of learning.

STEM Literacy is one aspect that fulfill 21st century skills. STEM Literacy is ability to identify, apply, and integrate concepts from science, technology, engineering and mathematics tounderstand complex problems and to innovate the solution of the problem (Balka, 2011). Students who deeply learn about science, technology, engineering and mathematics then they'll ready to use that knowledge in the real world. However, the process of STEM learning need STEM Literacy as the dinamic process of the learning. STEM learning as the approach used that train students to reach STEM Literacy as the goal of learning (Zollman,2012)

PhET (Physic Education Technology) interactive simulation is multimedia learning that can support student to learn directly by simulation. PhET interactive simulation is nonprofit project that developed by university of colorado. According to (Powell, 2017) PhET help to improve STEM literacy through STEM learning. This might be a good chance for us to apply PhET simulation as the pre-treatment in STEM learning before students laerning about an electrical circuit.

Arduino is an electrical component that could control the whole circuit which is connected to the arduino. Mostly the learning process in electricity only

use cable and bulb in learning process. Here in the research, researcher gonna use Arduino as the microcontroller of the circuit. We change the cable by protoboard and bulb changed by LED (Light Emitting Diode). By connecting the circuit to the arduino we can control every LED in the circuit. When it's turn on and turn off and how it's turning on. Because this experiment is an attractive experiment, so we decide to introduce them into arduino. We also use Arduino as the main component in projects of STEM learning. Students are asked to design the traffic light using Arduino.

According to the background, this research aims to improve students' STEM literacy in electricity by applying STEM learning helped by Arduino-PhET based experiment. This prior research will be conducted by designing and analyzing the lesson plan, the worksheet, and the test instrument about STEM Literacy onelectricity implemented to 8^{th} grade students.

1.2 Research problem

The research problem of this study is "How STEM learning on electricity using Arduino-PHET based experiment can improve 8^{th} grade students' STEM literacy?"

Elaborating the research problem, the research attempt to explore the following question :

1. How is STEM learning lesson plan applied to STEM Learning on Electricity using Arduino-PhET based experiment to improve students STEM Literacy?
2. How is STEM learning worksheet applied to STEM learning on electricity using Arduino-PhET based experiment to improve students STEM Literacy?
3. How is STEM Literacy test Instrument applied to STEM learning on electricity using Arduino-PhET based experiment?

1.3 Reasearch objective

This research objective is specied as follows:

1. To investigate how STEM learning on electricity using Arduino-PHET based experiment can be applied on the lesson plan to improve students' STEM literacy?
2. To investigate how STEM learning on electricity using Arduino-PHET based experiment can be applied in making the worksheet in order to guide students' to achieve the STEM literacy?
3. To investigate how STEM literacy can become the indicator to make the test item for student to improve students' STEM literacy?

1.5 Research Benefits

The results of this study are expected to provide the following benefits:

1. Teacher could use the result of the research as one of the references how to improve students' STEM Literacy in electrical circuit topic.
2. Students' can learn how to solve the problem by make a project to overcome the problem and also it can be directly applied in the world work.
3. For another reasearcher, this research can be as the research that support other researcher to develop the study about how to improve students' STEM literacy in learning electrical circuit.

1.6 Organization of Research Paper

The reserach paper organization contains detail of sequence of each chapter in the research paper. The paper consist of 5 chapters, as follow:

1. Chapter I Introduction

   This chapter describe the background of research, research problem, research objective, research benefit, definition of terms and organization of the research.

2. Chapter II Literature Review

   This chapter presents theories that support the problem of the research. This chapter consist of the explanation about virtual test and critical thingking.

3. Chapter III Research Methodology

   This chapter describe in details about research method that was used in the research, population and sample, operational definition, research instrument, instrument analysis, research procedure and research plot.

4. Chaprter IV Result and Discussion

   This chapters Present the result of the reasearch such as validity and realibility of STEM Literacy Test Instrument, implementation of STEM Learning, implementation of STEM worksheet Students STEM Literacy after using STEM learning as an approach.

5. Chapter V Conclusion and Recomendation

   This chapter describes about conclusion of the research and recommendation for the further research which relevant with this research.

1.7 Limitation of Problem

In order to make the research become more focused, the problem is limited as follows:

1. The stage of STEM learning which is used in this research is based on the Jolly (2014) which stated that there are 6 characteristic of STEM learning.
   a. The focus of STEM learning must be on the real world problems and issues.
   b. Engineering design process is the guide of STEM learning.
   c. STEM learning must consist of hands-on inquiry and open-ended exploration.
   d. Involve students to productive teamwork.
   e. STEM learning apply an exact math and science content based on students learning.

f. STEM learning allow for multiple right answers and reframe failure as a necessary part of learning.

2. Arduino-PhET, arduino is a component that added as media that used by student to learn about the microcontroller in electric circuit. While PHET is the Interactive simulation program that has been published by university of Colorado. Here, Students are asked to make the prototype of traffic light. Every group will have the opportunity to modify the traffic light. It can be in the form of intersection traffic light or triangle traffic light, etc.
3. Educational organization publish the definition of STEM literacy that become the area of researchin this research:
   a. Science literacy according to National science Education Standard (1996) is knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs and economic productivity.
   b. Technology literacy according to National Assessment Governing Board (2010) is capacity to use, understand, and evaluate technology as well ass to understand technologycal principles and strategies needed to develop solution and achieve goals.
   c. Engineering literacy according to Organization for economic cooperation and development (2013) is ability to systematically and creatively apply scientific and mathematical principles to practical ends such as the design,manufacture, and operation of efficient and economical structures, machines, processes, and systems.
   d. Mathematical literacy according to Program for international Students Assesment capacity to identify, understand, and engage in mathematics, and to make well-founded judgements about the role that mathematics plays in an individual's current and future private life, occupational life, social life with peers and relatives, and life as constructive, concerned, and reflective citizen.

4. The topic of the project in STEM Learning that has been done by student is Electrical circuit topic based on IGCSE Cambridge curriculum. Student are asked to make the project of electrical circuit with arduino (micro controller).