

CHAPTER I

INTRODUCTION

1.1 Background

Living in digital era challenges human being to be able to develop their knowledge and their skills. We should be able to solve the real world problem by analyzing the phenomena and be adapt with the current condition changes (Kennedy & Odell, 2014). However, this will never happen if humans have never made innovations in their lives. Thus, technology has a great role to keep the dynamics life. Reeve (2013) mentions that technology is a human innovation that used to modify natural world in order to fulfill human needs and make human life better yet saver. According to International Technology Education Association (2003), everyone should be technology literate, means they have capability to understand the use of technology in order to solve the real-world problem. Technology affects many great aspects in our life, such as in medical treatment, agriculture, and also in education.

Learning is a process which a person converts knowledge from one person or another media and applied it as a skill to achieve learning objective. Today, this definition of learning cannot be seen as the education pillars due to the globalization. Learning is not only seen as a shallow activity as only converting knowledge, but also can improve the ability of a person to be able to adapt with the technology development to solve unimaginable problems in the future. UNESCO declares there are four purpose of learning to reshaping the global education, such as learning to know, learning to do, learning to be, and learning to live together. By integrating cognitive ability, provide usable skills, and exposing individual values of a person, a person's condition can contributes a lot in the citizen life (Delors,2013). Due to the urge of technology, the learning instruction should be moved from the

traditional *paper and chalk* method into hands-on activity in order to obtain the learning objective above.

The content that will be taught for the students should be linked with the use of technology and enable to engage students' understanding, skills, and performance. Science is the study of natural phenomenon that should be measured systematically. Science considered as the perfect content because science education objective is that students are prepared to solve the real-world problems on their environment by producing appropriate solutions (Firman, 2015). However, during the process, there are several problems that should be faced by science educators. The assumption of science is a hard and difficult subject to learn make students are afraid to learn science and they will fail to pass on this subject, before even they trying, especially in Indonesia. This condition reflected on Wulandari and Jailani study in 2015 shows that Indonesian students have a lack of problem solving skills, reasoning and proofing, communication, connection, and representation. Students only have a great memorization, while they would not be able to apply what have they learn into the real-world problems. The science learning phenomena will become worse if science educators do not innovate themselves and leads to interfere a nation's educational ranking in global. This is proven by Indonesian's students mathematical average scores in eighth grade (this time Indonesia does not include grade IV) only 386 and ranks 38th out of 42 countries, while in science, Indonesia ranks 40th out of 42 countries with an average value of 406 based on Trends in International Mathematics and Science Studies (TIMSS) result in 2011 (Kompas, 2012).

As the answer to the problem above, a new educational reform is made and named as STEM education. STEM is an acronym of four integrated disciplines, there are science, technology, engineering, and mathematics. STEM Education associates with instructional process that can be applied in both formal and informal education which science, technology, engineering, and mathematics are used as the ground of

the instruction (Gonzalez & Kuenzi, 2012). According to Bybee (2013), the aim of STEM education focus on the fulfillment jobs in STEM professions, ability to adapt with each STEM literacy, willingness to actively involves in STEM fields, and the increase of students achievement. STEM education facilitates students to have better understanding and meaningful learning by crosscutting the science concept with the engineering design process (Anwari, et *al.*, 2015).

Electricity topic is chosen because it represents the science concept that relates with our daily life. In learning electricity, most students have a difficulty to understand the nature of electric current on the electric circuit and its application in daily life (Garnett and Theagust, 1992). Based on the interview with physics teacher in school sample, the electricity concept usually taught using multimedia demonstration and rarely conducting experiment using actual electrical component. The consideration is to equipment damage in the laboratory and conventional tools tend not to be practically used during experimental activities because it has bigger size. Therefore, the researcher introduces Protoboard experiment as the alternative experiment because it only needs smaller components and easier to conduct rather than conventional experiment.

Arduino is a hardware platform based on a simple microcontroller which processing the specific processing language. The benefits of using *Arduino* is people can make prototype various electrical design without spending lot of cost. As a open source microcontroller, *Arduino* can be used for the beginners to arrange and test the electric circuit design. Based on the previous study by Rubio et *al.*, in 2013, *Arduino* experiment is a proper activity to enhance students' learning and attitude towards STEM education. The researcher assumes that *Arduino* might enhance students' curiosity and engage creatively to solve real-world like problems by create many innovative things it capable of. In this research, *Arduino Protoboard-based experiment* is proposed by the researcher to develop students' STEM literacy in learning electricity. Due to the limitation of electricity on the school laboratory,

Arduino is the appropriate alternative tools to implies electricity concepts since it can provide an introduction the use of current technology and engineering for students.

According to the background, this research aims to improve students' STEM Literacy in learning electricity by applying STEM Learning helped by Protoboard Based Experiment. This prior research will be conducted by designing and analyzing the lesson plan, the worksheet, and the test instrument about STEM Literacy on electricity implemented on 8th grade students.

1.2 Research Problem

According to the background which has already stated, the problem of this research “How does STEM Learning on Electricity with Arduino Protoboard Based Experiment Improve 8th Grade Students' STEM Literacy?”

1.3 Research Question

Elaborating the research problem, the research attempts to explore the following questions:

- 1.3.1 How is STEM Learning lesson plan applied to STEM Learning on Electricity using Arduino-Protoboard Based Experiment?
- 1.3.2 How is students' respond after using STEM Learning accompanied by student-based worksheet on electricity?
- 1.3.3 How is students' STEM literacy improvement after STEM Learning on electricity using Arduino-Protoboard based experiment?

1.4 Limitation of Problem

In order to avoid widening of problem on this research, the research will be limited for following things:

- 1.4.1 The stages of STEM learning implemented in this research is based on Anne Jolly (2014), there are: *Involve students in productive teamwork, Immerse students in hands-on inquiry and open-ended explorations, Focus on real world issues and problems, Guided by engineering design process, Apply rigorous mathematical and science content, and Allow multiple right answers and reframe the failure during learning.*
- 1.4.2 Arduino is an open-source physical computing platform based on a simple microcontroller which processing the specific processing language. The Arduino version that implemented on this research is Arduino Uno with Arduino IDE 1.6.7. (Banzi, 2011).
- 1.4.3 Protoboard experiment is electricity experiment using Arduino breadboard to realize electrical circuits that supports a variety of compatible components and require minimal skills to be implied. (Mountain, 2004).
- 1.4.4 Arduino project conducted in this research is making traffic light project that represent electricity concept.
- 1.4.5 STEM literacy is measured according to Zollman (2012) which consist of 4 (four) components such as Scientific Literacy, Technology Literacy, Engineering Literacy, and Mathematical Literacy.
- 1.4.6 In this research, the electricity topic is limited by Cambridge IGSCE Syllabus on Physics 0625 for examinations 2016 on competence 4.2 about Electrical Quantities and competence 4.3 about Electrical Circuits.

1.5 Research Objective

This research objective is to improve students' STEM Literacy in electricity by applying STEM Learning helped by Arduino-Protoboard Based Experiment.

1.6 Research Benefits

This research is important to conduct because to provide some benefits to various sides including:

1.6.1 Students

The results for this study are expected to provide students to have better understanding in using technology on their daily life by thinking creatively, enhance students' performance in STEM-related content, and encourage students to be a STEM-literate citizen.

1.6.2 Teachers

The result for this study are expected to provide teacher to create opportunities for students to make connections between Science, Technology, Engineering, and Mathematics by enhancing students' knowledge through problem solving.

1.6.3 Researcher

The result for this study are expected to provide reference for researcher who has same focus study.