CHAPTER I
INTRODUCTION

1.1 Background

Education in every country should follow the current development to face competition in various areas of life especially science and technology aspects. The 21st century is a century of technology, where several countries have implemented many policies which related to scientific education (Lou, Shih, Diez, & Tseng, 2011). Many scholars argued that the integration of science, technology, engineering and mathematics (STEM) education have advantage to the national economy, teachers, and institutes which have been working to develop this STEM education program (Tseng, Chang, Lou, & Chen, 2013). STEM education provides knowledge and skills that are transferrable to future problem and can help them to approach college and their career (Diana Laboy-Rush, 2011). It coherent with the goal of IGCSE curriculum such as help the students to understand about scientific theories and method work together, the study of practice of science are affected and limited by social, economic, technology, ethical and cultural factors, the application of science in everyday life may be both helpful and harmful to the environment and the last knowledge that science overcomes national boundaries (Cambridge International Examinations, 2013). By implementing STEM education, the researchers believed that students can study mathematics and science and to consider their careers in engineering, science and technology in the future (Isha Decoito, 2014).

STEM is considered as instructional strategies, teaching method, interdisciplinary approach and part of curriculum. Bybe (2013) argued that STEM is an approach functioned as a tool for facilitating students become STEM literate. It can be stated that the goal of STEM is creating STEM literate students. In line with Reeve (2013) that the goal of STEM approach is providing learning atmosphere where the students can use science, technology, engineering, and math in daily life

context which can be connected it into certain occupation and surround environment until STEM literate students who can compete in the knowledge-based economy.

In recent years, STEM become trending pedagogic topic in every education scoop in many countries. The interest of researchers in the transformation of game-based learning technology, especially in STEM education is growing rapidly. Meluso, et al., (2012) stated that science content learning and self-efficacy of the students which taught through STEM and game-based learning significantly increased. Rapini (2012) argued that the games "*World of Goo*" will help the player to understand the topic of static equilibrium.

Nowadays, learning science with Arduino becomes the interesting discussion.Arduino or microcontroller is the device that can control how the component in the circuits are connect or disconnected independently. Huang (2015) argued that providing students with exposure to Arduino and open-source is able to enhance physics classroom beyond the traditional book problems and traditional demonstration labs. One of the example project which commonly done with Arduino is traffic light. Arduino can be programmed by the software and control light intensity. Carro, et al., (2014) added that "The Color of Light" project with Arduino is able to generate students' curiosity and allow teacher to emphasize the technology of LED in daily life.

The subject which commonly taught by using STEM approach is Physics. Suwarma, et al., (2015) argued that "Balloon Powered Car" as a teaching media to deliver linear motion topic could increase students' motivations and achievement in final examination, and gave engineering learning experience. On the other hand, Anwari, et al., (2015) argued that the using of STEM approach through of DC motor project could acquire the topic of energy transformation, electricity and magnetism.

One of the topic on STEM which make confusion to the students is electricity. Students considered that physics as one of the most prevailing and problematic subject in the realm of subject which caused their low motivation and negative attitude towards learning (Guido, 2013). The problems on learning electricity have been found by the previous works. Mulhall, et al., (2001) stated that Electricity is a problem, as it involves extremely complex and highly abstract concepts and is thus totally dependent on models/ analogies/ metaphors. Cao and Brizuela (2016) also added that the students is hard to

explain the role of electric field in the interplay of the different element of a circuit. There was also alternative conception about electric current in the electric circuit which generated by the students. According to Samsudin, et al., (2016) mostly students think that current flow fast because of turning on or off the switch of lamp, they didn't even realize about drift speed of current and electric dipole. To handle these students' problems on investigating the electrical concept and application, the novel STEM learning using Arduino-Android Game based experiment will be first proposed.

According to the background, this research aimed to improve students' STEM literacy in electricity by applying STEM Learning using Arduino-Android Game Based Experiment. This prior research will be conducted by designing and analyzing the lesson plan, the worksheet, and the test instrument of STEM Literacy on electricity implemented to 8th grade students.

1.2 Research Problem

The research problem of this study is "How does the STEMLearning using Arduino-Android Game Based Experiment on Electricity Improve 8th Grade Students' STEM Literacy".

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

1.2.1 How is lesson plan applied to STEM Learning on Electricity using Arduino-Android Game Based Experiment to Improve 8th Grade Students' STEM Literacy?

1.2.2 How is worksheet applied to STEM Learning on Electricity using Arduino-Android Game Based Experiment to Improve 8th Grade Students STEM Literacy?

1.2.3 How is STEM Literacy instrument test applied to STEM Learning on Electricity using Arduino-Android Game Based Experiment?

1.3 Research Objective

This research objective is to improve students' STEM literacy in electricity by applying STEM Learning using Arduino-Android Game Based Experiment.

1.4 Research Benefit

The result of this study expected to provide following benefits:

1.4.1 Teachers

STEM is a new approach which integrate knowledge, concept and skills systematically. In science teaching learning, teacher can use this approach to provide scientific knowledge as well as its application in daily life. Therefore, meaningful learning will be achieved.

1.4.2 Students

Since STEM consisting some aspects: science, technology, engineering and mathematics. Therefore, the students will experience to learn mathematics, many kinds of scientific knowledge which can help them in the requirement of engineering and technology in the future and make them for being STEM literate students who have high thinking and practical skill.

1.4.3 Other researcher

The result of this research contributes to develop STEM learning and reference to other research which explain about STEM literacy.

1.5 Research Paper Structure

This research paper is consisted of five chapters and arranged based on these following structure:

1.5.1 Chapter I: Introduction

This chapter explains background of the research, research problem, research questions, limitation of the problem, research objective, and research benefit.

1.5.2 Chapter II: Literature Review

This second chapter deals with literature review which mainly explain about the theory of STEM Learning, STEM Literacy, Android Game and Arduino Uno, and the science topic chosen on the research theme.

1.5.3   Chapter III: Methodology

The third chapter presents research method and design, sample used, research hypothesis, instrument test development and research plot.

1.5.4   Chapter IV: Result and Discussion

Chapter four details the data both quantitative and qualitative obtained in this research. The author analyzes and interpretation it coherently with the research question in the first chapter.

1.5.5   Chapter V: Conclusion and Recommendation

The last chapter of this research elucidates the conclusion which based on the research problem and the result which analyzed and interpreted. This chapter also add the recommendation for future research.

1.6 Limitation of Problem

1.6.1   The investigated STEM learning is adopted from Anne Jolly (2013), she described that STEM lessons have six characteristics such as focus on real-world issue and problems, guided by the engineering design process, immerse students in hands-on inquiry and open-ended exploration, involve students in productive teamwork, apply rigorous math and science content, and allow multiple right answers and reframe failure as necessary part of learning.

1.6.2   STEM literacy in this research is based on the four strands of STEM Literacy from Zollman (2012) which specified STEM literacy into scientific literacy, technology literacy, engineering literacy and mathematics literacy.

1.6.3   Arduino Uno, the microcontroller board based on the ATmega328. In this research, it is used to make a project about circuit to control LED lamp. It is connected to PC and run by a software, *Arduino 1.6.7*.

1.6.4   Android game used is *M Games Science: Electrical Circuits*, developed by *Rahul Dilip Ogale and Udita Rahul Ogale*. This game can challenge students to solve the problem regarding basic connection: series-parallel circuit and resistance.

1.6.5 In this research the topic is Electricity and Magnetism explained from the number of content 4.1 until 4.3. In IGCSE Cambridge Physics Syllabus for 8rd grade of junior high school.