CHAPTER I
INTRODUCTION

1.1 Background

Current workforce, living and citizenship is now dominated by ill-defined problems that often require multidisciplinary solutions which cannot be done by individual alone. Furthermore, physical assets which were the key resources in the pass century are now replaced by human capital that are required to possess particular skills and characteristics that enable them to do complex and non-routine activities. It means societies are changing dramatically and in the future children will be facing jobs that probably do not yet exist. Thus, there is the need for education reformation to provide children with learning experiences which is able to develop new skills needed for future workforce and also nurture life skills to help them succeed in life and citizenship which is called as 21st century skills (Griffin & Care, 2015).

Many educational organization such as United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Children's Fund (UNICEF), the Organization for Economic Co-operation and Development (OECD), the Partnerships for 21st Century Learning (P21), and Assessment and Teaching of 21st Century Skills (ATC21S) have identified and outlined the framework of 21st century skills on their disseminated documents. In 2010, ATC21S project explored the 21st century skills that could be taught and learned which includes critical thinking, problem solving, decision making and collaboration skills that can be combined into a set of skills called collaborative problem solving (CPS) (Griffin & Care, 2015).

Similarly, educational reformation also happening in Indonesia as National Curriculum 2013 revision document acknowledged the need to tackle 21st century challenges where science learning is expected to attribute children with learning skills that include critical thinking, problem solving and creativity as well as able to communicate and collaborate (Kemendikbud, 2017), which are the essential component of collaborative problem solving.

Collaborative problem solving has been identified as a particularly promising task that draws upon various social and cognitive skills, and that can be analyzed in classroom environments where skills are both measurable and teachable (Hesse et al., 2015). CPS has attracted increased attention as numerous surveys, reports, and research studies over the past two decades revealed that this set of skill is strongly needed (Fiore et al., 2017). However, most studies focused on computing and communication technology (Nyerges et al., 2013), professional development (Kopp et al., 2012; Ritella et al., 2015) and college students (Nokes-Malach, Meade & Morrow, 2012; Zou & Mickleborough, 2013; Ryan, 2016). Only a few has studied CPS on school level (Lau et al., 2016; Gu, Chen et al., 2015; Kim & Tan, 2012). OECD added CPS to its Programme for International Student Assessment (PISA) administered by 60 countries, including Indonesia, in 2015. However, findings on CPS of students in participating countries has not elaborated yet since in 2015 the survey focused on science while CPS only was served as one of minor areas of assessment.

Project-based learning, is believed to be one of appropriate pedagogical approach to foster CPS in which activities are designed in such a way mimicking real world context (Häkkinen et al., 2016). Similarly, current Indonesian curriculum also suggest teacher to apply activity based instruction which is contextual and involve collaboration such as project based learning in teaching science (Kemendikbud, 2017). Learning in real world context is important to prepare children for future workforce which often have problems that need multidisciplinary solutions and require collaborative work.

Project based learning is regarded as an efficient way to enhance students' collaborative skills (Baser et al., 2017) as they work collaboratively to research and create project that reflect their knowledge (Bell, 2010). Moreover, this kind of learning advances students’ problem solving skills (Bell, 2010). In terms of students’ perspective, the implementation of project based learning in science was found to be beneficial, enhance creativity, encourage research and provide permanent learning (Genc, 2014). Another study also show promising finding that after the implementation of collaborative science inquiry-based project, primary school students was able to develop collaborative problem solving competencies (Lau et al., 2016). However, there are several shortcomings of implementing project based learning such as time management issue (Chin & Chia, 2005) and difficulties in unpacking the ill-defined problem (Chin & Chia), as well as introducing design activities and problem solving stages (Hong et al., 2011)

On the other hand, Science Technology Engineering Mathematics (STEM) education has captured extensive attention internationally. The demand of more STEM professionals in many countries has been the reason of STEM education's rapid development worldwide. However, a survey report on K-12 engineering in US (NAE and NRC, 2009) revealed that the dominant STEM subjects which refer to science and mathematics, tend to be taught separately in siloes fashion. Thus, incorporating engineering into the learning is strongly suggested as it provides catalyst for integrating STEM education and making it more relevant to students' everyday experiences (Vest, 2009).

The engineering practices are regarded as promising vehicle to boost science learning and achievement (Yanyan et al., 2016). It is because when engineering design is used as a context for science learning, students can be more motivated and engaged to learn (Marulcu & Barnett, 2016). Moreover, the use of engineering design support the development of twenty first century skills (Guzey et al., 2016) as it provide students with an effective way to tackle open-ended problems (Yanyan et al., 2016), while at the same time it will deepen their understanding of crosscutting concepts and ideas from related disciplines (Hernandez et al., 2014).

In engineering design-based science, regardless the approach of engineering integration which is used, activities done by students always involve constructions of physical product as a mean to solve human problems (Marulcu & Barnett, 2016; Wendell & Rogers, 2013) and involve collaborative work as a team instead of individuals (Wendell & Rogers, 2013). When compared to many other field, engineering activities relies more on social involvement, cooperation and collaboration to solve the problems (Housholder & Hailey, 2012) where CPS skill could be fostered. Engineering practices is relevant with project based learning and it is an ideal basis for project based learning activities (Barroso et al., 2016). Moreover, utilizing engineering design process for well-defined outcome, will lead to exploration of the best solution based on particular criteria and constraint (Barroso et al., 2016).

As cited from Kompas (2018) Indonesia is in demands for manpower in the field of science and engineering due to the government's development focus on infrastructure. Unfortunately, the nation is currently lack of expertise in these fields. As compared to ASEAN countries, the number of students pursuing science and engineering major in Indonesia is the lowest. Only 15% Indonesian students are studying science and engineering in the university whereas in Malaysia, Korea and China the portion are 24%, 33% and 36% respectively (Kompas, 2018). The main reason of reluctance to choose these two majors is because students are relatively uninformed about the field of engineering, lack of academic preparation especially in science and have poor attitudes toward engineering career (Hirsch et al., 2007). Previous studies indicated that participation in engineering practices leads to the increase awareness of STEM careers and make it possible for the students to be more motivated in pursuing career in STEM field (Barrett et al., 2014; King & English, 2016; Moreno et al., 2016).

Science curriculum for middle school includes the concept of circulatory system, especially disease related to blood circulation system in human body. This topic is relevant for the students because it is one of the most important functions in their body. However, understanding concepts related to transport and circulatory system was often difficult for the students (Kurt et al., 2013), especially the youngster. The analogical model often be used to help students visualize and understand those concepts. Through the instruction integrating engineering design, students could use everyday materials to design and develop the model of devices and approaches to unclog blood vessels. By doing so it is expected that they can learn about blood circulation system, biomedical engineering, and conditions that may lead to health problem in blood circulation system. At the same time, student could act as medical engineer and required to work collaboratively to apply their understanding of science concept to solve real-world problems.

Thus, in terms of suitability of project based learning and engineering design with our curriculum to tackle 21st century challenges, it will be a good effort to implement engineering design project to improve science learning, especially to foster students' CPS, conceptual understanding and attitudes toward science and engineering career. However, it is important to remember that each student is a unique individual. Each student might learn differently one to the other. For instance, some learn best by observing, reading, listening, or do something. Even though students need multiple modalities to truly commit information to memory, most are typically stronger in one area than another. Thus, ensuring that the instructional strategy accommodates varied students' need in terms of how they learn best is important. It is because students who are taught in ways that fits preferred learning styles can be expected to enjoy learning and have better academic achievement (Shaughnessy, 1998). Similarly, Bobby De Porter (2014) contended that a person will learn and communicate easier using his or her learning style preference. Fleming (2006) also emphasizes that knowledge of, and acting on, one's modal preference is an important condition for improving one's learning.

However, earlier studies has not yet investigated how instructional strategy with engineering design-based science project accommodates students' needs in terms of their learning style to foster CPS, conceptual understanding and attitudes toward science and engineering career. Most studies are limited to examining emerging learning style of students in higher engineering education only.

In light to that, this study aims to investigate the profile of middle school students' CPS, conceptual understanding and attitudes toward science and engineering career after learning blood circulation system with engineering design project. Moreover, this study is expected to provide information for deeper understanding of how students with different learning style engaged in the lesson and develop aforementioned skills, understanding and attitudes differently.

Therefore, it is necessary to implement the study which is entitled “Profile of Students’ Collaborative Problem Solving Skill, Conceptual Understanding and Attitudes in regard to Learning Style after Learning Circulatory System Using ED-P”.

1.2 Problem Statement

“How is the profile of students’ collaborative problem solving skills, conceptual understanding and attitude towards science and engineering career in regard to learning style after learning blood circulation system using engineering design project?”

In order to make the problem more explicit, this study is guided and structured by the following research questions:

1) How does the implementation of instruction with engineering design project in blood circulation system topic in regard to students’ learning style?
2) How does the profile of students’ collaboration skill after learning blood circulation system using engineering design project?
3) How does the profile of students’ problem solving skill after learning blood circulation system using engineering design project?
4) How does the profile of students’ conceptual understanding after learning blood circulation system using engineering design project?
5) How does the profile of students’ attitudes toward science and engineering career after learning blood circulation system using engineering design project?

1.3 Aim of Study

The purpose of this study is to investigate the profile of students’ collaborative problem solving skills, conceptual understanding and attitudes toward science and engineering career in regard to learning style after they engage in instruction with engineering design project in blood circulation system topic.

1.4 Significance of Study

This study is expected to give contributions for researchers, students, teachers and readers as follow:

1) Provide empirical evident regarding students' profile of collaborative problem solving skills, conceptual understanding and attitudes toward science and engineering career
2) Contribute to innovation in science learning that accommodate varied learning style to foster skills needed in future workforce, life and citizenship.
3) Motivate teacher to do innovation through integrating engineering design into science instruction.
4) Raise students' awareness of possible career in STEM field.
5) As reference for other researcher who has similar focus of study.

1.5 Organizational Structure

This thesis comprises of five chapters. The first chapter describes the research background that includes reasons underlying the investigation of students' profile on collaborative problem solving skills, conceptual understanding and attitudes toward science and engineering career after learning blood circulation system with engineering design project. Research problem and questions, aims, and significance are also described.

The second chapter describes the literature review related to collaborative problem solving skills, conceptual understanding and students' attitudes. This chapter also describes features, advantages and limitations of project based learning and engineering design as well as the integration among them. Furthermore, it also includes elaboration of learning style model and blood circulation system concepts used as the context for learning.

The third chapter describes the research method that was used, that is descriptive analysis, followed by descriptions of research subjects, instruments, research procedures and data processing and analysis.

The forth chapter presents findings followed by analysis and interpretation. Descriptive and statistical analysis such as frequencies, tables and percentages were used in the data analysis and summaries. The results of both qualitative and quantitative data were presented by using tables and graph.

The last chapter presents conclusion drawn from analysis of the findings which is reflected upon the research questions. Implications of the study as well as recommendation for further research are also described.