CHAPTER I
INTRODUCTION

1.1 Background

A study conducted by the Program for International Students Assessment (PISA) in 2009-2015, Indonesia is in the tenth position from the bottom. In 2018, Indonesia positioned in the foot 9 within the science category. In 2022 Indonesia ranked 3 points higher than 2018 but the scores are decreasing for all aspects. The educational programs execution in Indonesia does not utilize the Higher Order Thinking Skills (HOTS) framework utilized to survey understudy accomplishment by PISA. In any case, in 2018-2019 this HOTS framework was connected amid the national exam. Of course, this lead to numerous complaints that school and study are not ready for testing with HOTS. In the 2015 Global Creativity Index (GCI), Indonesia positioned 115th out of 139 countries within the category of student creativity, while in 2023 Indonesia ranked 150th of 160 countries (Farantika et al., 2024). According to Torrance, creativity is a process including stimulating problems, deficiencies, gaps in knowledge, wrong elements, disharmony, identifying difficulties, finding solutions, making questions or formulating hypotheses about deficiencies through modified tests and retests (Asmawati 2017). Given the importance of creativity for students, it is natural that creativity should be instilled at an early age. However, there are still some obstacles or problems that trigger the low level of students' creativity, one of which is that students are still reluctant and confused in developing their imagination (Betaubun et al. 2018). This is due to the teacher's material being limited to explanation, and as a result students are not creative in completing the class activities. In the learning process, students imitate the work of their friends while teachers tend to teach one activity. The media used is only in the form of packaged books, and teachers do not appreciate the work done by students.

Furthermore, complex content is one of the causes of students' lack of conceptual understanding, particularly in science. Complexity science is based on contemporary research and thinking in 21st-century biology, which views systems

as non-linear and capable of adapting to changing contexts (Allen & Varga, 2006). Complexity material science assumes that natural living systems cannot be understood by studying their constituent parts separately due to their complexity (Fogelberg and Frauwirth, 2010). As a result, complexity science teaches people how to think by focusing on system patterns and the relationships between the components that make up the system. Human physiology is one of the more complex systems. Human physiology is one of the more complex systems. To understand the mechanisms of human physiology, various disciplines, such as biology, chemistry, physics, psychology, and the environment, are required (Eke et al., 2002), because the system is influenced by interactions between external and internal environments, and all organs work interdependently to maintain system balance. Human physiology is usually regarded as a tough subject (Slominski et al. 2019). The circulatory system is one of the topics covered in high school human physiology classes.

Student learning success is influenced by internal and external factors (Abdulkadhum Jabor AL-Muslimawi & Adhiem Hamid, 2019). One of these internal factors is the student's desire to participate in the learning process. Motivated students have a greater willingness to learn. They are also more persistent in learning (Koca & Koc, 2016). The importance of maintaining this in the learning process cannot be denied. By mobilizing students in activities during learning, students become more active in learning. In addition to internal factors, external factors also have a significant impact on improving student learning outcomes. An important external factor is the teacher, who must strive to achieve learning objectives in the classroom. One factor that determines teacher success is the use of learning models that are appropriate to the subject so that students can easily understand the lesson, master the concepts, think creatively, and actively participate in learning activities in the classroom. The product of the learning process is more productive in an active learning environment than in a traditional learning environment (Roblyer & Hughes, 2018). Therefore, understanding something can affect students' creativity. Inaccuracy in applying learning models affects the achievement of learning objectives, especially in science subjects. However, the trigger factor for low concept understanding is that students need to

be given more practice in solving learning problems in the past (Jacobsen, Eggen, & Kauchak, 2009) as cited by (Setiawan, 2016). This is supported by a study of science literacy in students of SMP N 4 Belik Pemalang, Central Java, which shows that the aspect of understanding and interpreting basic statistics has a low value, such as 21% for interpreting fundamental statistics and 24% for understanding the element in science topic (Hasasiyah et al., 2019).

Putri Dewita & Witarsa (2023) conducted a study that tested the effectiveness of learning using STEM in elementary schools. The results of his research stated that the experimental and control classes had different results in creative thinking skills, which initially had the same average in the pretest results. The experimental class had an average post-test score of 86.53% in a very creative category. In comparison, the control class had an average post-test score of 77.88% in the same category as the pretest scores, namely creative. This proves that applying the STEM learning model can improve students' creative thinking skills. The results of this study are also consistent with the results of research by Amin & Ibrahim (2022), Lumbantobing & Azzahra (2020), Nurwidodo et al. (2022), Septiyani (2022), which all state that there is an effect of using the STEM learning model on students' creative thinking skills. This means that the STEM learning model can utilize students' ability to think creatively and motivate students to be more innovative in learning. The STEM learning model allows students to generalize that form the basis of their creative thinking systematically. Conceptual understanding is the level of ability that expects students to understand the meaning of concepts, situations, and facts they know. The nature of physics learning objectives is to provide students with the understanding of mastering concepts and their interrelationships to solve related problems in everyday life (Hasdiana, 2018). Filgona et al. (2020) emphasize the importance of understanding concepts for students who have experienced the learning process. Understanding the concepts students possess can be used to solve problems related to issues in everyday life. According to Saputro & Pardiman (2012), students will understand the concept when they directly experience and actively participate in the learning process during the learning process. According to Eggen, as cited by Muhfahroyin (2009), understanding concepts can make various demands on thinking, such as

remembering, explaining, finding facts, giving examples, generalizing, applying and analogizing, and stating new concepts.

Based on this issue, the curriculum needs to be adjusted to the times and global needs, emphasizing 21st-century skills especially critical thinking skills and creativity. Innovative and interactive teaching methods must be introduced to increase student engagement in learning. According to the data, Indonesia must be better positioned to understand science materials. Understanding science material is very important to become a method of scientific thinking in evaluating the information obtained. In addition, (Dr. Vladimir, 1967). Permendikbud No.67-70 explains the basic framework and structure of the 2013 curriculum, which contains Core Competency 3 for Science Education, namely Understanding and applying knowledge (factual, conceptual, and procedural) based on curiosity about science, technology, and cultural arts related to phenomena and visible events. In addition, many psychologists and education experts argue that creativity is a psychological skill needed for success in school and in the future workforce. As such, teachers have an obligation to teach and nurture creativity in students. This study assumes the application of STEM learning methods in the learning process of science subjects to improve concept mastery and student creativity in secondary students.

STEM is an approach to learning and improvement that coordinating science, innovation, building, and arithmetic (Judith Ramaley, 2001) cited by (Breiner et al., 2012). Numerous teachers give ventures to assist understudies get it the circulatory framework utilizing basic ventures from plastic bottles and water. This ponder expects the human circulatory framework can be recreated as an electrical circuit venture. Although, it is troublesome for understudies to clarify the part of the electric field within the interaction of the different components of a circuit (Cao & Brizuela, 2016).

In any case, the STEM instructive approach can invigorate students intrigued in science and make strides students' concept authority and inventiveness. With the understanding of the concept of biology based on the concept of physics, the teacher must also be able to understand the relationships between concepts easily and pay attention to each characteristic of the concept to be combined but must revise the essential skills that will be taught to students, then

rearrange the basic skills between physics and biology with the same umbrella theme. The combination of biology concepts based on physics concepts directs students to find out and do so that they can gain excessive experience that can also serve to master the concept thoroughly and be helpful in everyday life. One method that can be used to achieve this understanding is STEM learning. Therefore, this study aims to improve students' concept mastery of human circulatory system and improve students' creativity by implementing STEM Learning-based electrical circuit projects. The origin of this technique dates to the 1970s when it was developed by the Science Curriculum Improvement Study (SCIS) of science learning programs. The model was developed by Bybee (2009). Based on the junior high school curriculum analysis of the human circulatory system, the curriculum provides practices for measuring heart rate based on physical activity. The books used in learning do not guide students in knowing or proving blood circulation in the human body. That is why the teacher always shows video simulations to solve this problem. This is a factor in the low understanding of blood circulation in the human body. The human circulatory system is crucial if the teacher just explains it. However, this topic is critical for every individual to understand so that we can understand how the human body works and functions. Additionally, people can realize maladies and therapeutic conditions related to the human circulatory framework, such as heart infection and stroke. Furthermore, creativity involves expressing ideas in diverse and engaging ways. This can improve students' communication skills and help them convey complex concepts more effectively. Successfully generating creative ideas can boost students' self- confidence. It has been shown that Indonesia has a lower rank in the creativity category.

Several research used the integrates study which Venegas (2000) developed a simple six-chamber circuit model in which each chamber is a capacitor connected to ground and two adjacent chambers are controlled by diodes representing the normal impedance current (flow) through the ventricles. Defares and colleagues implemented their model using discrete components and created an analog computer circuit to simulate hemodynamics with human behavior. EMEK et al. (2019) examined the electrical analogies of the basic parameters of the arterial system (blood flow, compliance, and resistance). The characteristic behavior of the

arterial system was described using an electrical circuit model known as the Windkessel model. This study had some limitations in defining the model. They did not perform calculations for the model in this study. They present an experimental study that interprets the dynamics of vessel behavior by observing the results. In this study, the Windkessel model, powered by a separate circuit. Menon (2012) describes a math-based human blood circulation model. The model consists of elements combined from venous, arterial, peripheral, pulmonary, and arterial segments. The heart model is simulated using four chambers (left and right atria and ventricles). A simple piston-based model operates the heart's pump mechanism for each chamber. The simulation consists of 19 first-order differential equations and is simulated with Matlab and Simulink. It calculates the volume, flow rate, and pressure in each segment. However, this website is limited by the predefined functionality and options of the block library. And not all students can access this website privately at home due to its expensive and paid price. However, there has been no research that implements electrical circuits into the circulatory system in junior high school students. Additionally, the project used is made directly by students during the learning process, so students can experience directly to explore their understanding and curiosity. Students can also understand the concept of 'what-if' that they try if an electrical component is installed incorrectly or has an error analogized to the human circulatory system what will happen if an organ is not connected or does not get enough blood.

The researcher tried to integrate biological material which is a human circulatory system with physics and electrical circuits. The topic uses the analogy of electrical circuits to relate to the function of the circulatory system in humans. This research uses quantitative data analysis, which will be collected from the pretest and post-test and will be anatomized using statistical styles to determine the effectiveness of the electrical circuit model compared to traditional tutoring styles. By probing the effectiveness of electrical projects as a tutoring system for the mortal circulatory system, this study aims to give sapience into an innovative approach to perfecting students' understanding of complex biology motifs. The findings of this study will contribute to developing further engaging and effective tutoring styles,

eventually improving students' concept mastery retention of knowledge in biology and students' creativity.

1.2 Research Problem

Considering the findings in the literature, this study aimed to discover answers to the following questions:

1. How can electrical circuit project about human circulatory system be implemented?
2. How does students' concept mastery improve about the human circulatory system?
3. How does students' concept mastery improve about the human circulatory system using electrical circuit project?
4. What is the correlation between STEM learning, concept mastery, and creativity with respect to the human circulatory system?

1.3 Research Objective

According to the analyst issue, the points of this investigate are:

1. To implement electrical circuit project into the learning activities on Human Circulatory System topic.
2. To improve students' concept mastery of the Human Circulatory System topic through an electrical circuit project.
3. To improve students' concept mastery of the Human Circulatory System topic through an electrical circuit project.
4. To find the correlation on implementing STEM learning towards students' concept mastery and creativity of Human Circulatory System topic.

1.4 Research Benefit

The results of this research are expected to provide the following benefits: 1) Should enhance students' concept mastery of the Human Circulatory System topic and create students' creativity to do a project by integrating the topic with physics. Implementing the electrical circuit project to learn about the human circulatory system topic helps students understand how the different areas are interconnected in the functions of its components. 2) Should help teachers find suitable learning activities, especially the human circulatory system, by implementing an electrical circuit project as a demonstration tool to teach the Human Circulatory System.

3) This research is beneficial and challenging because it creates new methods for explaining something to be implemented in learning activities. It should inspire other researchers to continue their research with different approaches.

1.5 Operational Definition

Operational definition spells out what the researcher must do by defining and giving meaning to the variable to measure the variable itself (Fred Kerlinger,1966) as cited by (Savitz., 1997). To achieve the expected goals and understand the existing ones in this research,

1.5.1 STEM Based Learning

Learning activities using an electrical circuit project to explain the human circulatory system topic during the teaching and learning process. This means that the learning will use STEM learning. The stages of STEM learning are formulating the problem, thinking about the ideas, designing, making, testing, and solving the problem. Because the topic is integrated into biology and physics. The model is intended as a 3D model to help students observe, analyze, and understand the subject. Then, students will do the worksheet and create the project on their learning.

1.5.2 Students' concept mastery

The conceptual mastery of this research is the competence of understudies that covers the level cognitive such as recalling (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and making (C6) based on Sprout Scientific categorization Changed (Hone & Blossom, 2008). This competence is measured by objective tests comprising of multiple-choice questions. The research starts by conducting a pretest to gauge students' basic knowledge and identify the extent of their understanding of the human circulatory system topic. This will be followed by an introduction to the learning concepts that will be implemented so that students understand what they will be doing and gaining. After all the learning activities have been conducted, a post-test will be given to assess students' concept mastery of the human circulatory system using the electrical circuit project.

1.5.3 Students' Creativity

Making a project will encourage students to be creative in learning science. Therefore, this learning activity is conducted to measure students' creativity. Creativity will be assessed through a project that students make through peer and teacher assessments. The indicator of creativity used in this research is referred to as the Creativity Product Analysis Matrix (CPAM). There are three creative dimensions: novelty, resolution, and elaboration. The germinal and original criteria were chosen as dimensions of novelty. The germinal criterion is products likely to provide additional creative product offerings. In contrast, the original criterion is how rare products with the same product idea combined into one indicate the same experience. For the resolution dimension, the practical and valuable criteria were selected. The value criterion refers to how others judge the product as valuable because it fulfills an economic, physical, social, or psychological need; the applicable criterion can be determined by how clear and practical the product is. And the last elaborate criterion is well-crafted and expressive. The well-crafted criterion refers to how the product looks and has been edited or revised concerning the idea's origin. In contrast, the expressive criterion refers to how communicative the product is.

1.5.4 Human Circulatory System

This research applied the subject of the human circulatory system as described by Curriculum 2013. The students will integrate the topic into physics since the media will use electrical circuits.

1.6 Organizational Structure of Research Paper

To form this, inquire about systematically organized, this inquire about is organized based on the arrangement below:

1. Chapter I: Introduction

This chapter gives foundation on STEM learning and its effect on students' concept dominance and imagination. It at that point talks about the inquire about issue, inquire about address, circumstance restriction, investigate destinations, investigate advantage, and the organization of the term paper. This chapter is the establishment of the investigation.

2. Chapter II: Literature Review

This chapter contains a writing survey of students' concept dominance within the human circulatory framework point, students' imagination through STEM learning, and pertinent inquire about on this theme.

3. Chapter III: Research Methodology

This chapter clarifies the investigate strategy and plan utilized to complete this investigation, the subject of inquire about, counting test and populace, rebellious utilized within the consider, information examination, and investigate methods.

4. Chapter IV: Result and Discussion

This chapter gives the inquiry about comes about and the reason for the information comes about. The comes about are utilized to reply the inquiries about questions that have been decided.

5. Chapter V: Conclusion, Implication, and Suggestion

This chapter concluded on the information analyzed within the past chapter. The suggestions examined the usage amid the think about, and the proposal for the taking after inquiring about was given.

1.7 Limitation of Problem

1. STEM Learning

In the 21st century, scientific and technological innovation will become increasingly important as we face the benefits and challenges of globalization and a knowledge-based economy. To succeed in this new high-tech, information-based society, students will need to develop their skills in STEM fields to levels far beyond what has been considered acceptable in the past". (NSF 2007). There are 6 stages of STEM learning will be used in this research based on Widodo (2021) ; formulating, thinking, designing, making, testing and solving.

2. The Human Circulatory System is one of the 8th-grade topics in Biology. The topic is around the blood circulation of the circulatory system based on the '*Ilmu Pengetahuan Alam' book* for class VIII semester 1 Chapter 6 about *'SiSTEM Peredaran Darah Manusia'* that has been prepared by the Government to implement the 2013 Curriculum.
3. The electrical circuit project is adapted from the electric current circuit based on the '*Ilmu Pengetahuan Alam'* book for class IX semester 1 Chapter 5 about

'Electrical and electric technology' that has been prepared by the Government to implement the 2013 Curriculum.

4. Students' concept mastery will be assessed by pretest and post-test methods, with cognitive thinking levels based on Bloom Taxonomy Revised, which includes C1 until C6. These learning objectives are very helpful for teachers in completing questions to measure students' thinking skills.
5. Students' creativity can be analyzed through the projects that will be made by students. The project about the human circulatory system on electrical circuit based on their creativity which will be assessed during the learning process as middle score and after learning process as final score to see the improvement.