CHAPTER I
BACKGROUND

1.1 Background

In the year 2015, a consensus was reached on the Agenda for Sustainable Development, which includes Sustainable Development Goals (SDGs). The implementation raises the question of education's role in achieving those objectives (Hoffmann & Siege, 2018). Since education contains the content of the SDGs and provides skills and abilities, it is essential to address the difficulties of a sustainable future. A tool for achieving Sustainable Development goals is education for Sustainable Development (ESD). It can guide society to transform to create a sustainable country (Kioupi & Voulvoulis, 2019). The activity of ESD designs for contextual, strategic, and reflexive knowledge for problem-solving in a specific cognitive field (Andersson et al., 2013). We must focus on education for Sustainable Development (ESD) to create a sustainable future (Gericke et al., 2019). Education is crucial in the global response to environmental concerns. The Sustainable Development Goals indicate how important Sustainable Development has become a global priority (Hiebert, 2013).

ESD covers all aspects of educational ideas, techniques, and processes that encourage individual or group contributions to Sustainable Development. ESD generally focuses on enhancing and developing personal skills so that the individual can contribute to and participate in processes of many types and dimensions of Sustainable Development. Essential skills like reading, writing, and numeracy include since it will be possible to create ways, concepts, and procedures to reach the dimension of sustainability. Also, higher-level abilities like creativity, solution-oriented, and actionability are essential for ESD (Hoffmann & Siege, 2018).

Education for Sustainable Development involves acquiring several competencies (de Haan, 2006). People with this competence will reflect on their actions, with considering their current and future social, cultural, economic, and environmental impacts, from a local and global perspective. They should also be empowered to act in complex situations in a sustainable manner, which may require them to strike out in new directions and move their societies toward sustainable development (Cebri, 2020). System thinking competency, anticipatory competency,

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normative competency, strategic competency, collaborative competency, critical thinking competency, self-awareness competency, and integrated problem-solving competency are on the list of essential abilities for sustainability. Systems thinking is a key ESD competency since it can help learners understand the complexity and dynamics of environmental, social, and economic systems. Understanding relationships, analyzing complex systems, considering how systems are embedded within many domains and sizes, and dealing with uncertainty are all examples of system thinking competencies (UNESCO, 2017).

However, dealing with a system's complexity can be challenging at any age, particularly challenging for students who must apply the system's cognitive capabilities during the learning process. Research on systems thinking focuses on the understanding of processes and patterns in complex systems. Understanding complex systems is difficult for students. Because students need to proceed from simple cause-and-effect to complex reasoning (Mambrey et al., 2020). System thinking, which should be considered a higher-order thinking capacity, involves the fundamental recall of data and encompasses abilities like evaluation and creativity (Schuler et al., 2018). Students studying the "Water Cycle" understand the processes but do not have a dynamic, cyclical, or systemic sense of the system. The researcher discovers that scientific knowledge and cognitive skills specifically, cyclic thinking and system thinking are necessary for pupils to understand the hydrosphere as a coherent system (Assarf & Orion, 2005). Another researcher also reported that students had difficulties developing their system thinking skills while learning about the rock cycle, which involved a cognitive framework with a dynamic and cyclic view of the system (Kali et al., 2003).

When faced with a complicated issue, system thinking is necessary to analyze the problem, grasp the relationships between its components, and the connections between the issue and other issues. Because more than one problem needs to be resolved, systems thinking offers a comprehensive solution. For this reason, focus and caution are necessary so problem-solving does not present other new problems (Saputra et al., 2022). Understanding the complex system is more complex, mainly because specific system thinking skills are necessary (Schuler et al., 2018). Understanding systems is crucial for a successful ESD, which requires the ability

to think in systems. Additionally, it deals with complex issues including the interactions between ecological, economic, and sociocultural issues (Fanta et al., 2020). Therefore, it is necessary to promote this skill among all students. Although system thinking in education is important, the integration of system thinking in education is still limited. The research on the ability to think in systems in education is also still very minimal, that's why the ability to think in systems in Indonesia has not been optimally trained (Nuraeni et al., 2020). The relevance of systems thinking to science education is growing internationally, a coherent conceptualization of systems thinking in educational settings across fields is still lacking (Mambrey et al., 2020).

To ensure that the earth is habitable for all living things in the present and future, ESD aims to raise awareness of natural resources and biodiversity (Fanta et al., 2020). The term "sustainability consciousness" describes an awareness or experience of sustainability phenomena. It also includes the impressions we commonly relate to our beliefs, attitudes, and behaviors. Sustainability consciousness is the ESD competence that students must master. Sustainable awareness is a concept of ESD competency that enhances the knowledge, attitudes, and behavior that necessary to create a life that is more sustainable (Olsson et al., 2016).

There are several difficulties in developing sustainable consciousness. Students have difficulty understanding and formulating ideas for solving issues related to education and Sustainable Development (Manni et al., 2013). Students typically already understand the concept of ESD, but they have not yet developed a habit of taking action. Other researchers stated that there was still a lack of consciousness among students in processing waste. Students still rare to carry out sustainable conscious efforts such as discussing environmental issues, using plastic bags, and also taking actions to overcome environmental problems. students are still lacking in practicing sustainable consciousness in everyday life (Agusti et al., 2019). Other researchers also showed results based on 3 categories of Sustainability awareness that were tested through a questionnaire, showing that the greatest value with behavior that had never been carried out was in the consciousness practice category.

This proves that students only know the theory without implementing it in real life situation (Clarisa et al., 2020) .

The 2013 national curriculum is already being implemented in schools without explicitly stating a commitment to ESD, it is still only focused on comprehension and encourages habituation of sustainable behavior (Listiawati, 2011). In fact, in the field of education especially in schools, students are not encouraged to make efforts to reduce the impact of environmental problems. This is due to the lack of education that focuses on sustainable consciousness practices that are directly implemented in schools (Suwarto et al., 2021). Sustainability consciousness is more than just knowledge about sustainability. It is how an idea is incorporated into environmental, social, and economic issues, as well as psychological constructs related to knowledge, attitudes, and behavior regarding these issues (Yulianto et al., 2018). Most teachers adopt ESD by concentrating on students' knowledge and comprehension but are not taught in a complicated and comprehensive way (Shulla et al., 2020).

Another researcher also reported the result shows that no knowledge focuses on change strategies regarding action-oriented. Almost all of them only focus on environmental problem knowledge and identifying the underlying causes of environmental problems. Instead of focusing on taking action to protect the environment, most of the student's textbook is still focused on environmental content (Eliyawati et al., 2022). However, environmental protection is still not considered essential to emphasize as a means of growing sustainable consciousness. Because many schools do not require students to try to reduce the impact of environmental issues and because students are not used to behaving in a more sustainable way of life. This is because no instruction regarding sustainable behaviors which directly implemented in the educational environment (Lestari et al., 2022).

The global issues described in Sustainable Development goals by UNESCO (2017) is a contextual problem that differs from many simulated or written problems used in traditional teaching and learning in the classroom. One innovative learning model that can orient toward ESD goals is applying STEM knowledge and skills. The contextual issues based on one of the SDGs make learning relevant and

meaningful. It can empower students to decide and take action in their local social, cultural, economic, and environmental context. It makes the students believe in their potential to make the world more sustainable (Loh et al., 2019). One of the Sustainable Development concerns is the environmental topic. Environmental education is the process of helping others acquire the knowledge, abilities, and values for people to take an active role as formal citizens in the development of an ecologically sustainable society (Osunji, 2021).

Furthermore, it can address through education. Environmental pollution topic is a relevant topic for ESD-based STEM learning. Because it will encourage students' consciousness about the environment, leading to informed concern for and active participation in resolving environmental problems, students will be able to find a mechanism where a clean environment will be enhanced consistently (Osunji, 2021).

Nowadays, various forms of pollution occur everywhere, including water pollution. Water pollution is categorized as a severe environmental problem because it can reduce the availability of clean water and trigger various diseases in society. Waste from industrial and agricultural activities contaminates human, animal, and plant water. However, several alternatives can be used to treat water. It starts by using technology or making water treatment using natural coagulants for water treatment because of the disadvantages of chemical coagulants. Water treatment removes suspended and colloidal particles, organic matter, micro-organisms, and other substances deleterious to health and reduces environmental impacts on the surrounding region (Jayalakshmi et al., 2017).

Teaching and learning with regard to science, technology, engineering, and mathematics (STEM) subjects is of great relevance to sustainable development (Hopkinson & James, 2010). STEM implementation increases students' awareness and concern for society, nature, and economic development. STEM is not something new in education terms. However, some people don't understand STEM. The implementation of STEM and ESD is a tool to make students more capable to solve problems, improving their knowledge, being more applicative (contextual), and building environmental awareness (Fakhrudin et al., 2021). STEM learning model helps students solve real-life problems and train higher-order thinking skills.

STEM model encourages students to understand concepts through problem identification and product creation as a solution to these problems. It is necessary to update the current teaching material by considering the appropriate learning model in order to achieve learning objectives (Setyowati et al., 2022).

Many researchers have researched treating water using environmental plant media, such as aquatic plants (*water bamboo* and *water jasmine*), *moringa seed, hyacinths, lettuce, watermelon and papaya seed,* and others. Moringa seeds use as a natural coagulant in reducing metals in water. The fine collision of Moringa seeds can cause coagulants in the impurities contained in the water (Ariyatun et al., 2018). Water hyacinth *(Eichhornia crassipes)* is an aquatic plant that lives in fresh waters that absorbs nutrients for its growth. The water hyacinth takes up many nutrients, which causes the hyacinth to absorb liquid waste, and various types of metals (Alfarokhi, 2016). Watermelon and papaya seeds contain natural polymers that can use as natural coagulants. Proteins and carbohydrates in these grains are natural polymers that can use as natural coagulants (Anggorowati, 2021). So, the use of plants as a medium for wastewater treatment can be an alternative to treating the water.

According to the explanation, systems thinking then relates to our role in the world: how do we handle societal challenges, how do we organize in a sustainable way, and how is the relationship between system and environment, and to build the sustainable consciousness among people around the world. Therefore, this competency needs to be built early in the school environment through simple projects that can be implemented in STEM teaching and learning. There is much research on increasing system thinking among students, and several studies also reported sustainable consciousness among students. However, no one connects system thinking and sustainable consciousness in the context of ESD. There is no research related to Plant-Modified Water Filtration as STEM-Based Learning to Enhance Secondary Students' Sustainable Consciousness and System Thinking on Environmental Pollution. Based on the background described, this research aims to investigate the impact of sustainable consciousness and system thinking through simple projects on science topics in Junior High School students.

1.2 Research Problem

The problem of this research is "How does Plant-Modified Water Filtration as STEM-Based learning can enhance secondary students' sustainable consciousness and system thinking on the environmental pollution?".

a. Research Questions

1. How does the plant-modified water filtration as STEM-Based learning can enhance secondary students' sustainable consciousness on the environmental pollution?

2. How does the plant-modified water filtration as STEM-Based learning can enhance secondary students' system thinking on the environmental pollution?

1.3 Operational Definition

a) Sustainable Consciousness

The data of sustainable consciousness taken from the questionnaire developed by Gericke, et al., (2019) using Sustainable Consciousness Questionnaire-Short (SCQ-S). The instrument could operationalize the concepts of sustainable consciousness by measuring knowingness, attitudes, and behavior with environmental, economic, and social dimensions described by UNESCO. Researcher will modify the test item based on the research topic and will be given twice, before and after the implementation of the water treatment.

b) System Thinking Competency

The system thinking characteristic that will be measured is the declarative or conceptual knowledge, modelling system, solving problems using system models, and evaluation of system models. This characteristic will be tested using the test item and evaluated using the heuristic competence model of system thinking (Riess & Mischo, 2010).

c) Plant Modified Water Filtration

Wastewater contains components that cause various diseases. Therefore, turbidity in wastewater must be reduced. The use of natural coagulants for water treatment can be done in several ways, one of which is plant media. Plant modified water filtration is a waste water filter using plant media. This plant-based water filtration will enable students to choose the most suitable type of plant to be used in the water filtration process.

1.4 Limitation of Problem

Focusing on the research problem that has made before, this research has several limitations to produce a better outcome as follows:

1) Sustainable consciousness

Sustainability consciousness (SC) includes thoughts, feelings, and actions based on experiences and perceptions. Sustainable awareness is limited to fostering knowledge, attitudes, and behavior based on awareness of environmental, social, and economic factors to create a more sustainable life.

2) System thinking competency

System thinking is thhe ability to recognize, describe, model (e.g., to structure, to organize), and to explain complex aspects of reality as a system (Riess & Mischo, 2010). The heuristic competence of system thinking is developed to measure the system thinking of students. It indicated four dimensions: declarative/conceptual systems knowledge, system modeling, solving problems using system models, and evaluation of system models. And will be focusing on the sub-capability 1. Which is basic knowledge of system theory, determining using systems elements, assessing the need of using a system model for processing a present problem and determining the structural (Schuler et al., 2018).

3) Learning STEM-ESD by creating plant modified water filtration on Environmental pollution topic

Environmental pollution topic is the learning materials that are given to 7th grade students based on the 2013 curriculum. The learning model used in

this activity is STEM-ESD. There are several stages, which are formulating the problem, thinking, designing, constructing, testing, and redesigning.

1.5 Research Objectives

The objective of this research is adjustment from the research problem which are:

1) To investigate the impact of sustainable consciousness in secondary student through plant modified water filtration as STEM-Based learning on the environmental pollution.

2) To investigate the impact of system thinking in secondary student through plant modified water filtration as STEM-Based learning on the environmental pollution.

1.6 Research Benefit

1) For teachers

   The result expected will give information about the use of plant modified water filtration can be the alternative to enhance the sustainable consciousness and system thinking competency in learning the environmental pollution topic

2) For students

   After this research, the students can increase their consciousness learning science. Beside this research can give the information how the project can affect their system thinking competency.

3) For researchers

   The result expected will give the information about the implementation of plant modified water filtration as in learning the environmental pollution topic or as a reference for implementing the similar research.

1.7 Organization of Research Paper

Chapter I: Introduction

The first chapter is introduction which is in this chapter several points was explained such as the background of this research, the research problem, research question, operational definition, the limitation of the research, research objectives, research benefits, and the organization of this research.

Chapter II: Literature Review

The second chapter is literature review which is in this chapter contains the theory of the research variable. It begins from the explanation of STEM Education on Sustainable Development (ESD) Based Learning, Water Treatment using Plant Modified, Sustainable Consciousness, System Thinking Competency, until Environmental Pollution Topic.

Chapter III: Methodology

The third chapter is about research methodology where in this chapter consist of research method and design, population and sampling, hypothesis and assumption, research instrument, data analysis, and the procedure of this research.

Chapter IV: Result and Discussion

The fourth chapter discusses the findings of this study's data analysis. It consists of recapitulation, calculation, and data explanation. This chapter contains all the answer for the research questions.

Chapter V: Conclusion, Implication, and Suggestion

The fifth chapter draws a conclusion from the information gathered in the previous chapter. This chapter also provides the author's recommendation for further research.