ANALYSIS OF STUDENTS' SYSTEMS THINKING COMPETENCY PROFILE ON ECOSYSTEM ISSUES

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Abstract

Systems thinking competency is one of the key competencies for sustainability. It's seen as an important competency to support the development of sustainability practices. This research aims to analyze the profile of students' systems thinking competency on ecosystem issues. The research method used in this study was a quantitative descriptive method. The subjects in this study were 50 tenth-year students at one of the high schools in the City of Bandung. The research instrument used was a test instrument in the form of eight essay questions. The test instrument was developed based on the aspects of systems thinking competency. The instrument used in this study has been declared valid and reliable based on the results of judgement by the experts and the results of test item analysis (R= 0,78). Students' systems thinking competencies were analyzed and classified into four categories, namely, low, medium, developing, and advanced. The results showed that the students' systems thinking competencies varied in each aspect. In general, it was concluded that students' systems thinking competencies were in the moderate category. This shows that students' systems thinking competencies still need to be improved. Systems thinking competency can be improved through the application of learning strategies that involve analyzing the relationship between components in a system as well as its application in daily life.

Keywords: systems thinking, ecosystem, learning strategy

1. Introduction

Systems thinking competency is one of the competencies related to the ability to think and analyze a system and its constituent elements. Based on UNESCO (2017), systems thinking competency is defined as the ability to recognize and understand relationships, the ability to analyze complex systems, the ability to understand the way in which systems are embedded in different domains and different scales, and the ability to deal with uncertainty. Systems thinking competency is one of the important competencies to acquired by students, especially in relation to analyzing a complex system. Arnold & Wade (2015) stated that the concept of systems thinking was first initiated by Barry Richmond in 1987 and has developed and continues to be redefined by experts through various perspectives.

A person's mastery of systems thinking competencies can support better problem solving skills (Kourayem & Ghadim, 2021). It is because mastery of systems thinking competencies allows a person to view a phenomenon comprehensively to understand the elements that exist within a problem or a system. Gilissen et al. (2020) stated that someone who has systems thinking competency will be able to reason biological phenomena regarding the characteristics of a system so that it can create a more coherent and complete understanding. In addition, Johariah et al. (2023) stated that the students will easily associate one topic with another if they have a good system thinking competency. This will help students to have a more complete

understanding of the topics they learn.

Systems thinking competency is one of the eight key competencies determined by UNESCO as a competency that needs to be mastered in order to support sustainable development (Bozkurt & Bozkurt 2024). Systems thinking competency as a key competency to support sustainable development goals (which can be achieved through education) has several aspects or indicators. The first aspect is the ability to recognize and understand relationships, the second aspect is the ability to analyze complex systems, the third aspect is the ability to understand the ways in which systems are embedded in different domains and different scales, and the fourth aspect is the ability to deal with uncertainty (UNESCO, 2017). Semiz (2017) emphasized that achieving the SDGs involves many interconnected aspects or components including economic, social, and environmental aspects. Such patterns and perspectives can be understood if a person has qualified systems thinking competencies. This underlies the importance of systems thinking as a competency that needs to be mastered to support sustainable development practices.

Knowledge about sustainable development can be taught to students through education. Education for sustainable development or ESD is expected to equip students with competencies that can support sustainable development practices, including systems thinking competency. Various topics at school can be taught through the application of ESD (Kusumaningrum et al., 2022). One of them is ecosystem topics in Biology. Ecosystems can be defined as a community of organisms that exist in an area along with the physical factors that interact with these organisms (Urry et al., 2021). Ecosystem material is one of the biological materials that can be learned through observing the surrounding phenomena that occur in nature (Rahayuningsih et al., 2023). Nurfadilah & Rochintaniawati (2021) stated that the concepts in ecosystem material that students need to understand include ecosystem components and their interactions, energy flow, productivity and ecological pyramids, biogeochemical cycles, and community dynamics.

Based on the description of systems thinking competencies and its relation to ecosystem topics, students with qualified systems thinking competencies will easily understand the ecosystem topics. The other way around, learning about ecosystems through identifying ecosystem components and analyzing the interrelationships between the components in the ecosystem can be used as an attempt to equip students with systems thinking competencies. Mastery of critical thinking competencies and ecosystem concepts will make students more concerned and sensitive to the surrounding environment, especially to the changes in the components that make up the ecosystem that can cause ecosystem imbalances (Salsabila et al., 2024). Furthermore, this understanding and competence is expected to encourage students to contribute through real action as an effort to maintain the ecosystem and support sustainable development.

Based on the description above, which states the importance for students to master the systems thinking competency, especially in its relation to the ability to learn and understand subject matter, it is necessary to analyze the ability of students' systems thinking. The profile of students' systems thinking competency can be identified through the analysis conducted in this study. The results of the study can be used by teachers in determining learning strategies. Developing the right learning strategy is expected to improve students' system thinking competencies.

2. Methodology

The research method used in this study was a quantitative descriptive method. Quantitative descriptive method is a research method that can be used to describe, show or summarize data in a constructive way that refers to a statistical description of the data obtained (Sudirman, 2023). The population in this study were students of class X in one of the high schools in the City of Bandung. The sampling technique used was purposive sampling. The sample of this study was 50 students. The research instrument used is a test instrument in the form of eight essay questions related to ecosystem issues. The test instrument was developed based on the aspects of systems thinking competency. The instrument used in this study has been declared valid and reliable based on the results of judgement by the experts and the results of test item analysis (R= 0,78). The data obtained were analyzed using descriptive statistics to determine the percentage and

distribution of students' systems thinking abilities in each aspect. The level of students' systems thinking competency was determined by referring to the systems thinking competence assessment rubric developed by Semiz & Teksöz (2019). There are four categories of systems thinking competencies, namely, pre-aware, emerging, developing, and mastery.

3. Results and Discussion

There are various factors that influence the development of systems thinking skills. Some things that contribute to the systems thinking skills are self-confidence, self-efficacy, motivation and external factors such as the environment and interactions with others (Bungsu & Rosadi, 2020; Mar et al., 2023). Percentage category of students' system thinking ability in each aspect. Table 1 shows the profile of students' systems thinking competencies on ecosystem issues.

Tabel 1. Percentage category of students' system thinking competency in each aspect

Aspect	Category	Percentage (%)
The abilities to recognize and understand relationships	Pre-aware	10
	Emerging	34
	Developing	20
	Mastery	36
To analyse complex systems	Pre-aware	28
	Emerging	24
	Developing	28
	Mastery	24
To think of how systems are embedded within different domains and different scales	Pre-aware	10
	Emerging	38
	Developing	28
	Mastery	20
To deal with uncertainty	Pre-aware	40
	Emerging	28
	Developing	24
	Mastery	8

Table 1 shows that students' systems thinking competencies are varied in each aspect. Mastery of each aspect as a whole indicates better systems thinking ability. The first aspect of systems thinking competency is the ability to recognize and understand relationships. Among all four aspects of systems thinking, this aspect is the basic aspect (Arnold & Wade 2015). A person's ability to understand relationships is the basis of systems thinking competence. The data shows that most students have mastered this aspect in fact, 56% of students are at the developing to mastery level. However, there are still some learners who are in the pre-aware category. Mastery of this first aspect allows students to more easily master system thinking competencies. Therefore, it is necessary to strive for learners to master this aspect well.

The second aspect of systems thinking is the ability to analyze complex systems. Unlike the first aspect, in this aspect, the ability to analyze the elements in a system more comprehensively is expected. In this aspect, the ability to recognize the relationship between components is improved to the ability to understand the interrelationship that exists in the elements of a system. Based on Table 1, it can be seen that the ability of students in this aspect is certainly balanced in each category. This needs to be a concern so that students at least have the ability to analyze complex systems in the developing and mastery categories. Ghros et al. (2018) stated that the ability to analyze complex problems is difficult to master because it requires in-depth reasoning. Amanda et al. (2024) stated that the ability to analyze various complex problems can be improved through practice and habituation, for example, through the application of learning models that train reasoning skills.

The third aspect of systems thinking is to think of how systems are embedded within different domains and different scales. The domains referred to in this aspect include economic, social, and environmental domains. Meanwhile, the scales referred to in this aspect is the level of a system such as national and international scales. These domains and scales are closely related to the SDGs (Mensah, 2019). The percentage of students' ability in this aspect is mostly in the emerging category. In addition, a total of 48% of students are in the developing and mastery categories, which shows that most students have an awareness of the involvement of economic, social, and environmental domains in a system.

The fourth aspect of systems thinking is to deal with uncertainty. This aspect emphasizes the ability to evaluate a system and predict various possibilities in the future. This is certainly related to the contextual application of concepts in everyday life. Table 1 shows that only 8% of students mastered this aspect. Overcoming uncertainty is the most difficult aspect compared to the previous three aspects. Uncertainty is related to the emergence of unfamiliar problems and various things that are difficult to predict (Bohm et al., 2024). This is what makes the competence of overcoming uncertainty difficult to master.

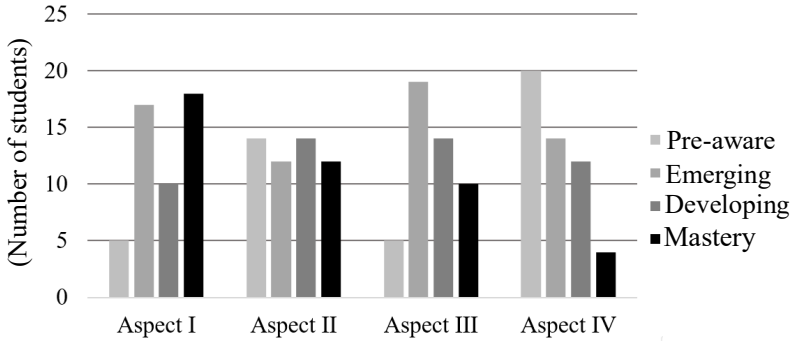

Figure 1. Level of systems thinking competency of the students on every aspect

Figure 1 shows a comparison of the level of the students' systems thinking ability in each aspect. The data obtained shows the tendency that the number of learners in the mastery category continues to decrease from the first aspect to the fourth aspect. As explained in the previous section, aspect I is the most basic aspect so it is quite easy to master. Meanwhile, aspect IV is the most difficult aspect to master. In addition, all learners who are in the mastery category for aspect IV are also in the same category for the other three aspects. The average ability of all learners for all four aspects is in the emerging to developing category. Therefore, learners' system thinking competence still needs to be improved.

Various ways can be done to improve students' systems thinking competencies. Education for sustainable development can be applied in the learning process that related to contextual issues such as climate change and environmental management to train and improve students' systems thinking competencies (Salsabila et al., 2024; Demssie et al., 2023). The thinking process to analyze the various components involved in a phenomenon and the interrelationships between these components can make students realize that supporting sustainable development practices requires the involvement of various aspects (Alisjahbana & Murniningtyas, 2018). In addition, various learning models and strategies that involve the process of reasoning and problem solving can be a solution to improve students' systems thinking competencies.

4. Conclusion

The results showed that the students' systems thinking competencies varied in each aspect. In general, it was concluded that students' systems thinking competencies were in the moderate category. This shows that students' systems thinking competencies still need to be improved. Systems thinking competency can be improved through the application of learning strategies that involve analyzing the relationship between components that exist in a system as well as its application in everyday life.

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