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Racking Analysis through Rasch Modeling to Measure Critical Thinking Disposition in Education for Sustainable Development Learning In Elementary Schools

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ABSTRACT: Education for Sustainable Development (ESD) aims to ensure that every student acquires the knowledge and skills needed for sustainable development and sustainable lifestyles. Another important aspect of ESD is the integration of cognitive and affective components, which are dominant in broadening students' understanding. The ability to be critically disposed is necessary to underpin students' perspectives on sustainable development. This study aims to develop and measure students' critical thinking disposition in ESD-oriented learning. The method used is a pre-experimental design with a one-group pretest-posttest design. The collected data on the critical thinking disposition of elementary school students will be processed through Rasch modeling using racking analysis techniques. The results of the study show that the critical thinking disposition instrument filled out by students experienced a significant 80% change in difficulty level, indicating an improvement in students' critical thinking disposition. This implies that students are enabled to contribute and participate in the process of sustainable development in various types and dimensions, with transformative and reflective processes that strive to integrate sustainability values and perceptions not only into the education system but also into students' daily lives.

KEYWORDS: Racking Analysis, ESD, Critical Thinking Disposition, Rasch Modeling, Elementary School Students.

INTRODUCTION

Education for Sustainable Development (ESD) is an integral part of supporting the Sustainable Development Goals (SDGs) program, where ESD is a global issue with 17 sustainable development goals (SDGs). One way to achieve these sustainable development goals is through education, as education serves as a means to introduce the concept of SDGs in an effort to change human perspectives and attitudes towards the environment. Most environmental problems stem from a lack of education about the environment and about ways to live sustainably. In relation to these issues, UNESCO has an approach to learning known as Education for Sustainable Development (ESD), which is seen as a solution. ESD generally focuses on the development and strengthening of individual skills, enabling individuals to contribute to and participate in the sustainable development process in various forms and dimensions (Hoffmann & Siege, 2018). ESD has three pillars that adopt the concept of sustainable development: environment, economy, and society (UNESCO, 2017). ESD is one of the ideas and principles of sustainable development conveyed to individuals through education (Nikolic et al., 2020). According to Mogensen & Schnack, ESD emphasizes action competence, which involves developing students' skills, motivation, and willingness to play an active role in finding democratic solutions to issues and problems of sustainable development (Mogensen & Schnack, 2010). In implementing ESD in learning, complete teaching tools, including instructions on how to use them, are necessary to help teachers adopt innovative teaching practices (Hamdu et al., 2021). The context for developing innovative learning lies in the concept of sustainable education as a fundamental strategy of global and national education (Hamdu et al., 2018).

In this context, education for sustainable development specifically involves acquiring a set of skills (de Haan, 2006). Developing competence requires the capacity to act and solve problems, and those with this competence can, through active participation in society, help shape and guide the future of society, as well as steer social, economic, technological, and ecological changes along the lines of sustainable development (de Haan, 1999). This means having the skills, competence, and knowledge to make changes in economic, ecological, and social behavior, without such changes merely being reactions to pre-existing problems (de Haan & Seintz, 2001). Education for sustainable development has taken on a significant role in discussions about acquiring future-oriented competence (de Haan, 2006). Therefore, in the educational process, it is necessary to apply ESD skills such as

systems thinking, anticipatory skills, normative skills, strategic skills, collaboration skills, critical thinking skills, self-awareness skills, and problem integration skills (UNESCO, 2017). Furthermore, research in 14 countries (Australia, Belgium, Canada, China, the UK, Estonia, Finland, Germany, Japan, Mongolia, Peru, Scotland, Sweden, and the Netherlands) reported that implementing ESD in schools was able to develop stronger and deeper critical thinking skills in students (Laurie et al., 2016). Therefore, students should be given opportunities in the classroom to engage in learning experiences that promote critical thinking, which can ignite the need to build and develop knowledge, attitudes/values, thinking abilities, and standards/criteria in an integrated manner, resulting in the ability to take responsible actions in contexts and situations of personal and social relevance (Vieira & Tenreiro, 2014).

On the other hand, when someone has critical thinking skills, a disposition to engage in thinking will emerge, characterized by clear and reasoned questioning, striving for a good understanding, using relevant sources, considering the overall situation, staying focused on relevant core issues, seeking multiple alternative solutions, being open-minded, courageous in decision-making, acting promptly, believing that something is part of a complex whole, utilizing others' critical thinking, and being sensitive to others' feelings (Hendriana et al., 2016). Ennis stated that a critical thinking disposition reflects the ability for critical thinking, and having a critical thinking disposition enhances cognitive abilities, particularly critical thinking skills.

Students who develop a critical thinking disposition tend to use critical and reflective thinking when engaging in problem-solving and analysis in various domains (Giancarlo & Facione, 2001). However, it should be noted that critical thinking disposition is not the same as critical thinking skills, but rather complements critical thinking skills (Cesur & Yaralı, 2019). Other studies have found a positive relationship between critical thinking skills and critical thinking disposition. Disposition has the power to enforce individual behavior and skills (Tishman, 1994). Skills will only be used if the strength of disposition increases. Given this fact, critical thinking disposition is crucial in an individual's life (Watson, 2008). Critical thinking disposition will be internalized into the mind, where there will be a desire to receive information, attempt to view events from different perspectives, reveal relationships between variables, think reflectively, seek evidence, practice skepticism, respect others' thoughts, and exercise tolerance (Eggen & Kauchak, 2006).

Based on the above explanation, this research focuses on developing items to measure critical thinking disposition applied in sustainable development-oriented learning. Another new aspect of this research is the use of Rasch modeling to analyze changes in the level of critical thinking disposition, specifically the difficulty level of critical thinking disposition items. The Rasch model analysis used is racking analysis, which can measure changes in each critical thinking disposition item. Through analysis using Rasch modeling, it is hoped to provide a picture of critical thinking disposition, helping teachers evaluate the learning process to develop critical thinking dispositions, especially in learning that promotes education for sustainable development in elementary schools.

METHOD

The approach used in this research is a quantitative approach. The quantitative approach was conducted using an experimental research method in the form of a pre-experimental design. Pre-experimental designs do not have a control group for comparison with the group that has been tested (Walliman, 2017). The pre-experimental design used in this study is a single group design (one-group pretest-posttest design). The single group design (one-group pretest-posttest design) involves three steps: (1) conducting a pretest to measure students' critical thinking disposition; (2) implementing education for sustainable development-oriented learning; and (3) conducting a posttest, measuring students' critical thinking disposition again. The difference attributed to the application of the experimental treatment is then evaluated by comparing the pretest and posttest scores (Ary et al., 2010). The single group design (one-group pretest-posttest design) is as follows:

O_1	X	O_2
Pretest	*Treatment*	*Postest*

Figure 1. Experimental Design One Group Pretest-Posttest Design(Creswell, 2014)

The research instrument used is the critical thinking disposition instrument developed by Facione in the form of a Likert scale (Facione et al., 1995). A description of the developed instrument can be seen in Table 1 below

Table 1. Critical Thinking Disposition Instrument

No	Indicator	Description	No. Item	Total Item
1	*Inquisitiveness*	Students tend to be curious about everything.	1,2,3	3
2	*Open-mindedness*	Students tend to allow others to voice their opinions; open-minded students have an attitude of tolerance and acceptance towards others opinions.	4,5,6	3
3	*Systematicity*	Students tend to or have the habit of working hard to solve problems with discipline, order, and systematically.	7,8,9	3
4	*Analyticity*	Students tend to be cautious about what happens next. This is related to anticipating the consequences of a situation, choice, and plan, whether good or bad.	10,11,12	3
5	*Truth-Seeking*	Students tend to always want the best understanding of a particular situation, accompanied by relevant reasons and evidence.	13,14,15	3
6	*Self-Confidence*	Students tend to trust the use of reason and reflective thinking to solve problems.	16,17,18	3
7	*Maturity*	Students tend to view complex problems, make timely judgments, and not procrastinate on what they can do.	19,20,21	3
Total				**21**

The instrument has undergone a field validation process, with data processed using Rasch modeling, as shown in Table 2 below.

Table 2. Results of the Validity Test of the Critical Thinking Disposition Instrument

Item No.	MNSQ	ZSTD	Pt. MC	Interpretation
1	1.38	3.65	0.73	Valid
2	1.24	2.17	0.74	Valid
3	1.02	0.28	0.78	Valid
4	0.95	-.48	0.77	Valid
5	1.70	5.46	0.55	Valid
6	1.03	0.38	0.75	Valid
7	1.06	0.70	0.83	Valid
8	0.81	-2.27	0.83	Valid
9	0.67	-4.13	0.85	Valid
10	0.63	-4.68	0.85	Valid
11	1.22	2.39	0.78	Valid
12	0.99	-0.13	0.82	Valid
13	1.09	1.04	0.81	Valid
14	0.99	-.05	0.78	Valid
15	0.69	-3.82	0.83	Valid
16	0.74	-3.07	0.80	Valid
17	0.69	-3.82	0.83	Valid
18	0.81	-2.23	0.82	Valid
19	1.05	0.58	0.80	Valid
20	1.04	0.44	0.80	Valid
21	0.67	2.39	0.80	Valid

To validate each item of the survey instrument, criteria were determined for measuring item validity through Rasch

modeling, namely: 1) Logit 0.5 < MNSQ < 1.5; 2) Logit -2.0 < ZSTD < +2.0; and 3) Logit 0.4 < Pt. Mc. < 0.85, where an item is declared valid if it meets any of these criteria (Boone et al., 2013). For the critical thinking disposition instrument, each item has met the criteria for the instrument to be declared valid and suitable for use, while the reliability test results show a Cronbach's Alpha value of 0.836, indicating that the research instrument used has a consistency degree of 83.6%. The study was conducted on elementary school students aged 10-11 years, with 47 students in each of the control and experimental classes. The results of the critical thinking disposition were then processed through Rasch modeling (racking analysis technique) using the Winsteps 5.3.2.0 application, which provides a description to analyze the level of critical thinking disposition of students in each control and experimental class

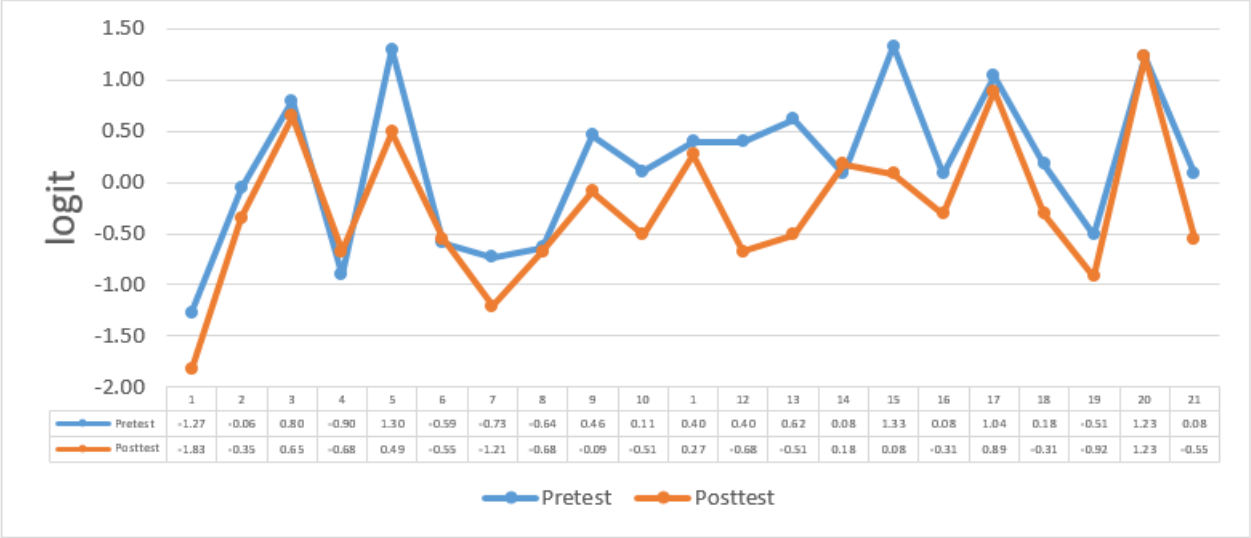
RESULT AND DISCUSSION

This research reveals changes or differences in the logit of each item of the critical disposition instrument in the pretest and posttest, analyzed through Rasch modeling using the racking analysis technique. The results of the pretest and posttest data processing can be seen in Table 3 below

Table 3. Racking Analysis Results of Critical Thinking Disposition

Item	Pretest	Posttest	Logit Difference	Description
1	-1,27	-1,83	0,56	Significant Decrease
2	-0,06	-0,35	0,29	Significant Decrease
3	0,8	0,65	0,15	Significant Decrease
4	-0,9	-0,68	-0,22	Significant Increase
5	1,30	0,49	0,81	Significant Decrease
6	-0,59	-0,55	-0,04	Non-significant Increase
7	-0,73	-1,21	0,48	Significant Increase
8	-0,64	-0,68	0,04	Non-significant Decrease
9	0,46	-0,09	0,55	Significant Decrease
10	0,11	-0,51	0,62	Significant Decrease
11	0,40	0,27	0,13	Significant Decrease
12	0,40	-0,68	1,08	Significant Decrease
13	0,62	-0,51	1,13	Significant Decrease
14	0,80	0,18	0,62	Significant Decrease
15	1,33	0,80	0,53	Significant Decrease
16	0,08	-0,31	0,39	Significant Decrease
17	1,04	0,89	0,15	Significant Decrease
18	0,18	-0,31	0,49	Significant Decrease
19	-0,51	-0,92	0,41	Significant Decrease
20	1,23	1,23	0	No Change
21	0,08	-0,55	0,63	Significant Decrease

If the logit difference of an item is > 0.5, a significant change occurs between the pretest and posttest results (Sumintono & Widhiarso, 2015). A positive value in the logit difference indicates a decrease in item difficulty, whereas a negative value indicates an increase in item difficulty. Further information on the logit differences or changes in critical thinking disposition items is presented in the following graph.



	1	2	3	4	5	6	7	8	9	10	1	12	13	14	15	16	17	18	19	20	21
Pretest	-1.27	-0.06	0.80	-0.90	1.30	-0.59	-0.73	-0.64	0.46	0.11	0.40	0.40	0.62	0.08	1.33	0.08	1.04	0.18	-0.51	1.23	0.08
Posttest	-1.83	-0.35	0.65	-0.68	0.49	-0.55	-1.21	-0.68	-0.09	-0.51	0.27	-0.68	-0.51	0.18	0.08	-0.31	0.89	-0.31	-0.92	1.23	-0.55

Figure 2. Graph of Logit Differences or Changes in Pretest and Posttest Results

Table 3 and the graph in Figure 2 show the logit changes or differences for each critical thinking disposition item. Items 1, 2, 3, 5, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, and 21 (a total of 17 items or 80%) experienced a significant decrease in difficulty. The item that experienced a non-significant decrease in difficulty was item 8 (1 item or 5%). The item that experienced a significant increase in difficulty was item 4 (1 item or 5%). A non-significant increase in difficulty was found in item 6 (1 item or 5%). These findings indicate that education for sustainable development-oriented learning supports the development of students' critical thinking disposition, but there is still a possibility that students may need more in-depth cognitive teaching support. Assessing students' critical thinking disposition is a series of activities carried out by teachers to obtain and process information about students' learning processes and outcomes in a lesson (Nurlenasari et al., 2019). The analysis of changes in each indicator of critical thinking disposition is presented in the following diagram

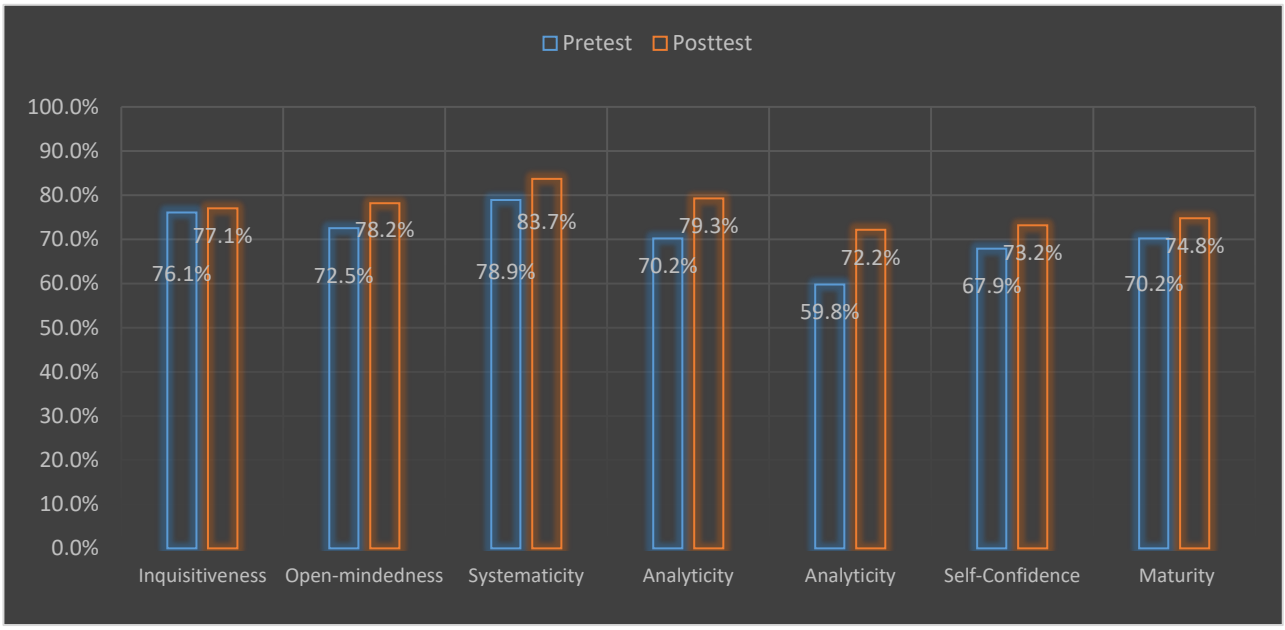


Figure 3. Percentage of Each Critical Thinking Disposition Indicator

Overall, the results of the study for the initial and final scores of students' critical thinking dispositions have increased. These results provide an overview that the critical thinking dispositions of elementary school students can be developed and have a relevant reciprocal relationship with students' critical thinking abilities. In addition, in the study of Demirhan & Köklükaya (2014), in addition to the relationship between the guided inquiry model and critical thinking or concept mastery, there is also a relationship between critical thinking, namely critical thinking dispositions with concept mastery, where there is a positive reciprocal relationship indicated by an increase in the accumulation of average concept mastery values that are balanced by critical

thinking dispositions. Although the critical thinking disposition value is in the middle and low criteria, there is an increase in critical thinking dispositions, this is very good because students who have critical thinking skills do not mean that the person will use them in situations that require the application of these skills. In addition, the results of the study on the internet-assisted value analysis model have a positive and significant effect in increasing critical thinking dispositions in students taking Pancasila education courses. Disposition is the willingness to use critical thinking skills (Pascarella & Terenzini, 2005). Some researchers, such as Delphi Project participants Facione (1990) and Ennis (1987) expanded the definition of critical thinking to include abilities and dispositions. Critical thinking disposition is defined as the tendency to do something given a certain condition (Ennis, 1987).

Critical thinking disposition refers to a tendency toward a certain pattern of intellectual behavior (Tishman, 1994). It is described as an individual's internal motivation to think critically when faced with and solving problems, evaluating ideas, or making decisions (Facione et al., 1995). Critical thinking disposition can be observed when someone encounters something new, and it doesn't necessarily have to be something pleasant, such as receiving new information (Widodo, 2021). Moreover, critical thinking depends on a set of skills and dispositions (Ana, 2012). Although most theories suggest that critical thinking disposition is a complex construct integrated through motivation and habits of mind, it is also recognized that, besides skills, disposition is an important component of critical thinking. This aligns with the assertion that critical thinking is a combination of two essential components: cognitive skills and dispositions (Ennis, R. H., Millman J., & Tomko, 2005). In the context of this research, within the framework of Education for Sustainable Development (ESD) and the implementation of Green Behavior, students not only engage in habitual green or environmentally friendly practices such as proper waste sorting, environmental care, water and electricity conservation, etc., but are also presented with new problems or information/news that foster critical thinking dispositions. These include understanding others' opinions, being flexible in considering alternatives and opinions, and being consistently ready to apply critical thinking skills. Furthermore, the learning approach developed is flexible, enjoyable, stimulating for student activity, and provides meaningful experiences for students, enabling them to become creative, productive, and innovative (Nur, 2019). This can be observed in responding to various problems or information about environmental issues or degradation in Indonesia that are presented or evaluated during the learning process. Cognitive skills are related to students' ability to engage in activities such as analysis, inference, evaluation, explanation, and self-correction in relation to problems, decisions, or judgments. On the other hand, disposition is a habit of mind integrated into students' beliefs or actions that foster critical thinking. Disposition also motivates students to use cognitive skills when engaging in higher-order thinking such as problem-solving and decision-making. A person with a strong tendency toward critical thinking has a consistent internal motivation to engage in decision-making problems using critical thinking (Facione, P. and Carrol, 2013). People who possess critical thinking skills do not always reflect these skills in their daily lives, and for this reason, critical thinking skills can be associated with disposition (Halpern, 1998). Critical thinking has two important dimensions: a framework of thinking and a series of mental activities (Cotton, 1991). Critical thinking consists of two components: the skill component and the disposition component (Ennis, 1996). Critical thinking disposition refers to the tendency or habit of regularly applying appropriate critical thinking behaviors. People who possess a critical thinking disposition are sensitive to opportunities for critical thinking, feel motivated to engage in it, and have the basic ability to carry it out (Emiliannur, 2019). Given the importance of the critical thinking disposition component, it has been stated that understanding one's critical thinking disposition is essential before developing critical thinking skills, as critical thinking disposition is considered the foundational requirement for possessing critical thinking skills (Facione, P. A., Norren, C.F., and Carrol, 2000). When someone effectively uses critical thinking, it indicates a congruence between their disposition and cognitive processes (Facione, 2011). This aligns with the assertion that critical thinking skills positively correlate with disposition (Facione, P. A., Norren, C.F., and Carrol, 2000).

As for the results of the analysis of each critical thinking indicator, it shows that the results of the study on the application of the education for sustainable development program with the application of green beehavior have not been able to provide an optimal impact on the curiosity indicator, even though curiosity is needed to encourage students to be interested in learning and exploring information in teaching and learning activities. Curiosity in the critical thinking disposition in this study can be seen in how students can show curiosity about the importance of waste management being applied in the home environment based on data or information regarding the percentage of waste from its source location. This curiosity shows that incoming information should not be accepted for granted but students must try to understand and assess the information (Widodo, 2021). In addition, curiosity can be identified from the desire to learn, investigate, and find out (Almerico, 2014). Students' curiosity arises when the knowledge they have cannot answer the existing problem. To stimulate curiosity, it is necessary to make students aware of the gaps in their knowledge (Borowske, 2005). In particular, the concept of information gaps is a source of academic curiosity that can be explored. This information gap can actually be bridged by teachers through contextual problems that require students to find the answers.

In addition, ESD learning with the application of Green Behavior is mostly carried out by students outside of school hours in the neighborhood, so classroom activities only reflect on a number of activities that have been carried out. Activities based on experience or trying to direct and relate to everyday life will be more meaningful (Yuliani et al., 2019). This is a deficiency experienced by researchers, the learning class should be conditioned to remain active so that it has the potential to facilitate students to think openly (Chen, 2015). However, in their learning evaluation activities, students showed a critical thinking disposition by having open minds, such as providing recommendations for making terraced or terraced agricultural land and juxtaposing it with trees to prevent erosion or soil erosion as an alternative to agricultural activities in the hills around the lake. Open thinking like this shows the disposition of people who think critically, where we must critically analyze the way of thinking, arguments and the strength of the arguments used (Widodo, 2021).

In this study, students showed critical thinking dispositions (systematic indicators) such as in overcoming the problem of clean water availability, the government made a regulation on tree felling, where the general public who were known to be felling trees either in the forest, in the garden or in the yard without prior permission would be fined at least to raise awareness to the public not to cut down trees carelessly and always close trees for the preservation of nature. The systematic reasoning process emphasizes a systematic, step-by-step, linear, convergent, straight thinking process towards a specific target goal (Ayalon & Even, 2008). Systematic ability means the ability to do something according to the right, effective, and efficient sequence, stages, steps, or planning, while analytical ability means the ability to detail or break down a problem into the necessary parts and be able to understand the relationship between these parts (Smolova, 2019). The components of systematic ability consist of determining possible strategies, implementing strategies and re-examining (Assaraf & Orion, 2010).

Furthermore, in the results of critical thinking disposition on the analysis indicator, this analysis indicator cannot be achieved if students do not master the previous cognitive aspects (Vermunt, 1996). Analytical thinking emphasizes the description of the main material into the detection of the relationships of each part that are arranged systematically (Brookhart, 2010). Analytical thinking skills include students' skills in applying logical thinking to collect and analyze information, design and test solutions to problems, and formulate plans (Arnold & Wade, 2015). Analytical thinking is useful for adapting and modifying information and includes cooperation that is useful in everyday life (Pennycook et al., 2015). Analytical thinking is very important for the success of students' professional future (Eckman & Frey, 2005). Analytical thinking assessment can be used as a benchmark for the quality of a graduate from compulsory education. This is because with analytical thinking skills a person must be able to express opinions, synthesize, solve problems, and build their ideas (Santhitiwanich et al., 2014). Analytical abilities can also be used to assess a person's intelligence in constructing their knowledge independently (Kao, 2014).

For the truth-seeking indicator, students have not been able to demonstrate a critical thinking disposition in seeking the truth related to environmental conservation issues, students who have a critical thinking disposition when faced with a problem will first check the problem faced before solving it, thus it can be concluded that the most important indicator in measuring truth-seeking is the truth-checking indicator (Arth et al., 2019). This is in line with measuring truth-seeking with research that the process of seeking truth when solving problems is based on the process of checking the truth behind the information related to questions/statements and coordination to make decisions about solving problems mediated by all objects concerned (Arth et al., 2019). Efforts to develop high-level thinking skills, especially in critical thinking dispositions can be done by providing learning that presents a number of issues or problems, in this study environmental problems were given. In line with this, that the process of students in building knowledge when solving problems, students carry out the process of seeking truth and also carry out the process of understanding problems, exploring, formulating, justifying, and proving possible errors in information in the questions given (Astawa et al., 2018). The process of students in building knowledge can be used as a basis for making decisions to search for the truth when facing problems and solving them (Moore, 2010). Therefore, critical thinking dispositions must be applied and developed in the learning process to produce students who have good critical thinking qualities.

Furthermore, the less than optimal self-confidence indicator is thought to be due to the lack of student experience in interacting with friends and teachers during the teaching and learning process. Students who are not used to interacting with others when learning will have difficulty communicating when faced with problems that must be solved together (Dabaj, 2011). The importance of student-student and/or student-teacher interactions can promote self-confidence (Maclellan, 2014). Teachers who actively build on what is already positive in their classrooms by supporting students in describing their own successes and progress, which in turn, is reported to increase self-confidence. Self-confidence is one of the characteristics of students that can influence increased learning achievement (Tavani & Losh, 2003). Students who have self-confidence will feel confident in their abilities so that they appear to have higher courage, social relationships, responsibility and self-esteem. In addition, self-confidence is adequate self-ability, aware of the abilities they have, and can use them appropriately (Şar et al., 2010). A person who has self-confidence will dare to try new things in new situations, because they feel safe enough, calm, and have their own

measures of failure and success (Wanabuliandari et al., 2021). High self-confidence can be present in students when they are confident in their strengths and this belief makes them feel capable of achieving various life goals. Self-confidence is one of the main sources of a person's potential in their life. If someone is no longer confident, for example, does not believe in their life goals and the decisions they make and does not believe in their potential and all their possibilities, then all their potential is lost. Therefore. Self-confidence is one of the characters that can make students optimistic and strong in facing various problems by optimizing all their abilities.

Finally, the low posttest score of the maturity indicator is thought to be influenced by low reasoning. The maturity indicator is characterized by the ability to actualize oneself, namely using and utilizing all talents, capacities, potentials and so on (Beaumont, 2009). The maturity in question is also the tendency to realize the complexity of problems, be open to other people's points of view, be aware of one's own and others' tendencies and biases, and consider these factors objectively before making decisions (Stedman & Andenoro, 2007). Cognitive maturity results in the acceptance that problems are often more complex than they first appear and therefore there may be more than one right solution (Friede et al., 2008). With their own will, students will train themselves to choose desires that will be realized in the form of actions, the realization of each of these desires uses the function of reasoning, so that people in their development period are able to carry out self-direction and self-control. With these two abilities, humans grow and develop towards maturity to live independently and responsibly.

CONCLUSION

These results provide an overview that improving students' critical thinking dispositions needs to be developed in various dimensions of learning, in addition, the process of implementing ESD in learning also needs to be developed in order to provide a better impact in the context of students' ability to respond to a number of environmental problems critically as an integral part of the success of sustainable development programs. The ability to think critically at least provides an understanding that the use of issues on sustainability awareness can be used as an effort to increase students' concern for sustainable development in their surroundings. Sustainable development programs integrated into learning can empower students to make the right decisions and take responsible actions in overcoming environmental problems, so that ESD functions to develop students' attitudes so that they can reflect on their own actions, by considering their current and future social, cultural, economic, and environmental impacts from a local and global perspective.

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