Education for sustainable development: investigating the sustainability consciousness and mathematical competence in the geometry for middle school students

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Abstract. Education for Sustainable Development (ESD) has long been socialized by the government to be developed and implemented in education, but currently, its implementation has not been carried out optimally. ESD is education that makes students aware of their environmental life in creating a sustainable future by not sacrificing future generations. One effort to achieve the ESD goal is to introduce it to the community. ESD has three main objectives namely economic goals, ecological / environmental objectives, and social goals. Awareness in each individual needs to be built from elementary and middle school age so that it is embedded and embedded in the mind to realize the goals of ESD. This is where the concept of sustainable development (sustainable development) needs to be studied and applied to schools. The purpose of this paper is to investigate the ability to solve geometrical problems based on ESD and Sustainability Consciousness, then develop mathematical competencies that are relevant to the components of ESD geometry. The type of research used is qualitative research. The results of his study showed that 46.25% of students were able to solve geometric problems based on ESD, while 53.75% of students were still categorized as unable to solve them, and 31.25% of students had Sustainability Consciousness in the economic dimension, but for the environmental and social dimensions they did not have.

1. Introduction
In Indonesia education for sustainable development began to be socialized since 2009. It is stated in the Ministry of National Education Regulation number 63 of 2009 on education Quality Assurance, the third part of Article 3 (1.c) confirms that education quality assurance adheres to the Education paradigm for sustainable development that is Education able to develop students to be a blessing for all nature [1]. According to UNESCO explained that ESD (education for sustainable development) or Education for Sustainable Development is a learning process based on the goals and principles underlying sustainability and related to all levels and types of education [2]. ESD implementation is one of the efforts in realizing the function of national education as stated in law number 20 of 2003 concerning the national Education system, which is developing capabilities and forming dignified national character and civilization in order to educate the life of the nation. In addition, ESD also strives to achieve the vision of national education in 2025, namely the formation of comprehensive and competitive intelligent Indonesians which includes intelligent spiritual, emotionally and socially intelligent, intellectual and intelligent kinesthetic.
The National Education Goals as stated in law Number 20 of 2003 concerning the National Education System Chapter II article 3, namely to develop the potential of students so that people who believe and fear the Almighty God, are noble, healthy, knowledgeable, capable, creative, independent and become a democratic and responsible citizen. The formulation of the above objectives is the main reference in the implementation of learning in any field of study, one of which is in the field of secondary school mathematics education.

Besides, the teacher is the person who provides changes to the education needed to achieve the SDGs. Their knowledge and competence are very important to restructure the education process and educational institutions towards sustainability. Teachers are required to face this challenge by orienting themselves towards ESD. However, efforts to prepare teachers to implement ESD are not yet sufficiently advanced. Much work needs to be done to direct teachers towards education for sustainable development, both in terms of content, teaching methods and learning. For teachers to be able to integrate ESD into mathematics learning, teachers must develop key sustainable competencies (including knowledge, skills, attitudes, values, motivation, and commitment). Besides general sustainability competencies, they also need mathematical competencies that are integrated ESD competencies. Based on this, the authors want to develop mathematical competencies that are integrated education for the development of sustainability in geometry.

2. Methods
The research method used is qualitative research. Qualitative research is methods for exploring and understanding the meaning of some individuals or groups of people ascribed to social or humanitarian problems [3]. This study uses qualitative and descriptive data to investigate students' abilities in solving ESD-based geometry problems and Sustainability Consciousness. Research subjects 80 junior high school students, then the data were collected through test data on the ability to solve geometric problems based on ESD and interview data. Then after analyzing the data, the researcher tries to develop ESD-based mathematical competencies which will be used in further research.

3. Result and Discussion
3.1 Mathematical Competence
Competence comes from Discussing English "competence" which is skill, ability. According to KBBI, competence is the authority or power to determine and decide on a problem. Niss states that mathematical competencies are divided into two major groups, namely: competencies related to the ability to ask and answer, and competencies related to symbolic, both linguistic management aspects and management aspects of symbolic components [4].

First Group Competence: The ability to ask and answer both in mathematics and using mathematics; mathematical thinking (Mathematical Thinking Competency), Expressing and Resolving Mathematical Problems (Mathematical Problem Handling Competency), Mathematical Modeling (Mathematical Modeling Competency), Mathematical Reasoning (Mathematical Reasoning Competency). Competency of the Second Group: Competence that is symbolically related to both the linguistic management aspects and the management aspects of the symbolic components. Mathematical Representation (Mathematical Representation Competency), Representation of Symbols and Mathematical Formalism (Mathematical Symbols and Formalism Competency), Mathematical Communication (Mathematical Communication Competency), Using Technology (Mathematical Aids and Tools Competency) [4].

This is also in line with the goals expected by the National Council of Teachers of Mathematics (NCTM) in mathematics learning. NCTM (2000) sets five standard mathematical abilities that must be possessed by students, namely problem-solving ability, communication skills, connection capabilities, reasoning abilities, and the ability of representation [5].

In the 2013 curriculum mathematical competencies are expected after students learn mathematics: 1) Understand concepts and apply mathematical procedures in everyday life (mathematical understanding); 2) Perform mathematical operations for simplification, and analysis of existing
components (mathematical connection); 3) Perform mathematical reasoning which includes making generalizations based on patterns, facts, phenomena or existing data, making guesses and verifying them (mathematical reasoning); 4) Solve problems and communicate ideas through symbols, tables, diagrams, or other media to clarify the situation or problem (mathematical problem solving and communication); 5) Grow a positive attitude such as a logical attitude, critical, careful, thorough, and not easily give up in solving problems.

Based on Niss assessment, the purpose of the NCTM and the 2013 curriculum objectives to eat the competencies to be developed in this paper are mathematical understanding, mathematical problem solving, critical thinking, reflective thinking, mathematical communication, mathematical connection, and mathematical representation. The following will describe the mathematical competencies: a) mathematical understanding is a mathematical ability that is very important and must be owned by students in learning mathematics. Understanding is the ability to see the relationship between various elements or factors in a problematic situation, or a way of interpreting situations and facts that are known based on the level of ability possessed [6]. Skemp there are two types of understanding namely instrumental understanding which means memorizing things separately or can apply something to routine calculations, meaning that students only memorize formulas and follow sequences of work and algorithms and relational understanding which is to do meaningful calculations on broader problems, and can associate a concept [7]; b) Mathematical problem solving, Problem solving is an attempt to find a way out of a difficulty, achieving a goal that is not immediately achievable [8]. So that problem solving is a process or set of activities directed to find a way out or a solution to the problems it faces; c) Critical thinking; In addition to solving problems that become a reference in the Education curriculum in Indonesia, especially at the junior high school level, namely critical thinking. Gokhale states that critical thinking is thinking that involves analyzing, synthesizing and evaluating concepts [9]; d) Reflective thinking. Higher order thinking skill include critical, logical, reflective thinking, metacognitive, and creative thinking [10]. Reflective thinking is a high-level thinking that requires active individuals, and is careful in understanding problems, associating problems with the knowledge they have acquired and carefully considering resolving problems; e) Mathematical communication, Mathematical communication is an ability to express mathematical ideas that include expressions of mathematical ideas through graphics, mathematical symbols, pictures or diagrams, presenting in the form of algebra or mathematical models in everyday life.

3.2. Education for Sustainable Development

Education for Sustainable Development (education for sustainable development) is a learning process (or teaching approach) based on goals and underlying sustainability and related to all levels and types of education [2]. ESD or Education for Sustainable Development is a learning process based on the objectives and principles that underlie sustainability and relate to all levels and types of education [14]. ESD supports five basic types of learning to provide quality education and foster sustainable humanity, namely learning to know, learning to be, learning to live together, learning to do, and learning to transform oneself and society.

ESD is meant as a broad and lifelong effort that challenges every individual, institution and community to view tomorrow as a day for all of us. ESD is a dynamic concept that includes a new vision of education that seeks the empowerment of people of all ages to take responsibility in creating a sustainable future [3]. Meanwhile according to Ali sustainable education is education aimed at fostering awareness, and developing competencies, knowledge, skills and attitudes to preserve the environment so that every activity in its expression maintains the fulfillment of the needs of future generations [11].

The Sustainable Development Goals (SDGs) are clearly an important milestone in this matter. The basic concept of ESD is described by the 1987 Brundtland Commission Report as' development that meets the needs of the present without compromising the ability of future generations to meet their own needs [12]. Based on the SDGs, the classical approach used in sustainable development only focuses on three pillars, namely: environmental, economic and social ecology of the community.
3.3. **ESD in Mathematics**

Education for sustainable development (ESD) is an education that makes students aware of their environmental lives in creating a sustainable future by not sacrificing future generations. In this case, to foster this attitude is by integrating ESD in mathematics from elementary to university level. According to vintere there are three competencies as the basic elements of sustainable development, namely: 1) Problem solving, critical thinking, action competencies and systems thinking; 2) imagination, critical and reflective thinking, systematic thinking, partnership, learning to cooperate, participation in decision making; 3) system thinking is the ability to see the relationship between different dimensions and the complexity of systems and situations [13].

Thus in the context of sustainable development mathematics has an important role in all aspects, namely, social, environmental and economic. First, mathematics provides an understanding of the world and as an approach to life; second, mathematics is a tool to describe and solve the problems it faces; third, mathematics contributes directly to sustainable development with various mathematical models for assistance in planning the process of resource recovery, controlling or reducing consequences.

3.4. **Investigating Sustainability Consciousness in Solving Geometry Problems**

Based on the results of tests given to 80 students, it was obtained that 46.25% of students were able to solve geometric problems based on ESD, while 53.75% of students were still categorized as unable to solve them. This confirms that middle school students have difficulty in completing it and have not demonstrated sustainability in the environmental, social or economic dimensions. The following is a recapitulation of the ability to solve ESD-based geometry problems and student awareness of the relationship of problems with sustainability in everyday life.

| Student Group     | Total students | Ability to solve problems (%) | Sustainability Consciousness |
|-------------------|----------------|-------------------------------|-----------------------------|
|                   |                | Able  | Unable |                        |
| High ability      | 15             | 96%   | 4%     | 86.7%                    |
| Medium ability    | 43             | 52%   | 48%    | 28%                      |
| Low ability       | 22             | 24%   | 76%    | 0                        |

From the table above shows 86.7% of students who are in the group with high mathematical ability have Sustainability Consciousness in solving geometry problems, 13 of them can only show the
economic dimension while the social and environmental dimensions have not been seen. Likewise, for mathematical ability group have Sustainability Consciousness was a low of 28%, whereas the low math skills of students who do not have the Sustainability Consciousness. So overall only 31.25% have Sustainability Consciousness in the economic dimension, but for the environmental and social dimensions they do not yet have. This is because students have not yet applied ESD-based mathematics learning, even though they have learned problem-based learning.

Interview data in this study were used to strengthen the test data of the ability to solve ESD-based geometry problems and sustainability awareness responses. Based on the results of the interview, students gave a number of statements about ESD-based mathematics problems. This is evidenced by the statement of students as follows:

Question: "have you ever known the problem-based math problem?"
Student: yes
Question: do you know ESD?
Student: never learn it.
Question: Have you ever solved an ESD based problem?
Student: Never before. But we have learned about problem-based problems "HOT"

Based on students' responses regarding ESD-based mathematics problems, students have difficulty in developing answers and are difficult to understand the questions given. As for students who have no difficulty in solving these problems because students more often learn and practice in solving problems and practice to explore their ideas. To overcome the difficulties and lack of awareness of students' sustainability, researchers try to design ESD-based mathematical competencies as described below.

3.5. ESD Design in Geometry Material

There are several keywords that are used to define ESD including the creation of awareness, responsibility (responsible learning), learning to change, critical thinking, and problem solving [2]. Therefore, the author will compile mathematical competencies relevant to ESD. To compile mathematical competencies relevant to the objectives of ESD, the following steps will be carried out:

1. Assessing the philosophy of mathematical competence and Education for sustainable development (ESD)
2. Reviewing the 2013 curriculum (K.13),
3. Reviewing Core Competencies (KI) and Basic Competencies (KD)
4. Assessing Mathematical Competence and determining indicators of each of its competencies,
5. Assess the components and objectives of ESD that are relevant to geometry material
6. Formulate mathematical competencies relevant to ESD on geometry material
7. Mathematical competencies relevant to ESD on geometry material

The following are examples of the preparation of mathematical competencies relevant to ESD objectives in the Pythagoras theorem material.

| Material          | Basic competencies        | Mathematical Competence | Indicator                          | Mathematical competencies relevant to ESD                      |
|-------------------|----------------------------|--------------------------|------------------------------------|----------------------------------------------------------------|
| Pythagoras Theorem| Explain and prove Pythagoras and Pythagoras theorems | Understanding | Give reasons for the truth of the statements of the Pythagoras theorem and triple Pythagoras | The ability to collect environmentally oriented information related to the Pythagoras and triple Pythagoras theorems from various sources to build knowledge |

4. Conclusion
Based on the above data exposure it can be concluded that only 46.25% of students are able to solve geometric problems based on ESD, while 53.75% of students are still categorized unable to solve them, and 31.25% of students have Sustainability Awareness in the economic dimension, but for the environmental dimension and social that they don't have. This causes students to have never studied ESD-based mathematics, so researchers try to develop ESD-based mathematical competencies and will be conducted in subsequent studies. Education for sustainable development (ESD) is an educational process that aims to foster awareness and develop cognitive and affective knowledge of students to preserve the environment in creating a sustainable future. Mathematical competencies are mathematical understanding, mathematical problem solving, critical thinking, reflective thinking, mathematical communication, mathematical connection, and mathematical representation. Based on the study of the philosophical mathematical and philosophical competencies ESD above, then the mathematical competencies relevant to ESD to be developed are, mathematical understanding, problem solving, critical thinking, reflective thinking, and mathematical communication

5. References

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