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Students' environment awareness through scientific approach in mathematics instruction

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Abstract. The purpose of this study is to develop learning designs that incorporate environmental contexts into mathematics learning. The method used is a qualitative method using a literature review approach. The selection of research objects and literature is achieved through purposeful sampling techniques and by employing data search engines. Mathematics research is being designed using a global context with a theoretical approach. The results have shown that there are different environmental contexts, especially those related to Papua. These contexts can be used in mathematical instruction. Mathematics instruction using this context is expected to develop students' awareness of the environment.

1. Introduction

Brazil, Indonesia, and Zaire are three of the ten countries with the highest biodiversity in the world. Unless it is focused solely on biodiversity on the mainland, Indonesia will be number two after Brazil. Brazil has the Amazon forest, which is the largest tropical forest in the world and therefore has the highest level of biodiversity [1]. However, when combined with ocean biodiversity, Indonesia is the nation with the highest quantity of biodiversity in the world.

Unfortunately, there is very little awareness among Indonesians about biodiversity conservation [2]. As a result, Indonesia became the sixth country with the most endangered natural biodiversity as a mega-biodiversity area [1]. Extinction of organism was not only caused by an unusual occurrence, such as a volcanic eruption or an explosion of space objects, but by the present extinction of the biodiversity due to human activities [3].

The United Nations has published the IPBES Global Assessment, which reveals the alarming state of global biodiversity in 2019. The study estimates that there will be about one million species of plants and animals on Earth that are threatened with extinction in the coming decades if there is no improvement. And the operation of man. He is the one who is utterly blamed [3].

Erroneous human intervention in exploiting the potential for biodiversity that results in the loss of biodiversity. Extinction of species as a result of damage to the environment. Humans have destroyed economic infrastructure, livelihoods, food security, health, and quality of life around the world. Based on this study, the abundance of native species in different land areas has decreased by 20% since 1900. After the 1500s, more than 680 vertebrate species have become extinct, and by 2016, 9 percent of animals bred for livestock and food raw materials have died. One-third of marine mammals and 33% of coral reefs are threatened with extinction. In the same way, 10% of insect species on Earth. In the meantime, the state of the amphibians is much more pitiful: more than 40% of the species are critically endangered [4].



Despite concerted efforts to minimize biodiversity loss, the rate of extinction will continue to be at least tens to hundreds of times higher than in the last 10 million years [3]. Examples of human activities that are accelerating the extinction of biodiversity to damage ecosystems are illegal logging of forests and land clearing, as well as new settlements. Although the forest is the last bastion to protect flora and fauna, it also has the function of preventing floods, drought, and reducing greenhouse gas emissions that cause global warming. Human activities, if left unchecked, can cause natural damage, which, in turn, can endanger human life [5]. Many main questions arose from the discussion, including:

1. What is the general awareness of the value of biodiversity?
2. Should people care about global biodiversity problems, or do only scientists, scholars, educators and environmental activists talk about them?
3. What is the biodiversity needed? How do species extinctions occur, even though this massive extinction has been predicted? Are people aware of biodiversity and its derivatives research?
4. How is education to play a part in environmental awareness? Is the learning of the environment confined to natural sciences and biology? What's with the Social Major Students? How are they aware of the world if they have never heard anything about it?

Actually, the Indonesian government has released a variety of government environmental regulations to overcome these problems. Such complex laws control and punish those who contravene environmental protection codes. For example, The Environmental Protection and Management Law of 2009 [6]. However, different government regulations do not make a reduction of environmental damage in Indonesia very effective. This problem is due to the low environmental awareness of the Indonesian population. The Indonesian government needs to raise public environmental awareness.

The public's environmental awareness cannot develop on its own. All elements of society, including education, must be concerned with the environment. Environmental education cannot achieve the objective without the participation of all members of the community. It is not possible to address environmental issues directly, as it calls for the collaboration of all actors and encompasses all aspects of society, including teachers and students, as elements of education [7].

Moreover, concern for the environment is the result of a learning process. Education has a very large contribution in developing students who have a positive attitude to the environment [8]. Mathematics, on the other hand, is a subject taught at all levels of education, from elementary to university, in Indonesia [9]. It is, therefore, important to integrate environmental education into mathematics. Environmental content is used for the learning of mathematics [10].

The integration of environmental content in mathematics has a multiplier effect. While learning mathematics, students learn about other sciences, especially the environment [11]. In order to the integration of the environment into teaching and learning of mathematics to be successful, the teacher has a crucial role [12]. The effectiveness of teaching in the classroom originates from the teacher. The teacher will adjust curriculum and instructional methods if well trained, well-versed and fully supported [13]. They need to improve their teaching quality through effective teaching planning [14]. One lesson plan is how to integrate the environmental context into mathematics learning.

How to integrate environmental issues into mathematics? What are the roles of a teacher in the teaching of mathematics? What styles of learning should be used? What is the technique used for studying mathematics? What topics could be integrated? Therefore, it is necessary to research the integration of environmental contexts in mathematics.

2. Method

The method used in this research is a descriptive method using the literature review. The steps in this research include the review of scientific papers on mathematics and environmental education, the selection of selected literature purposively, and learning design development.

The collection of libraries, especially scientific journals, is done using the Google Data Search Engine. The keywords used are the environment, environment of mathematics education, mathematics, and environmental awareness. The journal articles found were selected purposively. The criteria used are articles that discuss mathematics learning using environmental content as a learning context.

Furthermore, the study of learning theory is carried out in order to develop Learning Design. The construction of a learning design focused on selected environmental content and environmental knowledge that students want to develop. The choice of environmental context is unique to the environment and culture of Papua.

Learning design is also constructed using a scientific approach. Students are supposed to take a scientific approach, in particular, observations to improve environmental awareness. Students' knowledge is expected to increase their environmental awareness. There are four topics in mathematics that will be developed for learning designs, namely descriptive statistics, systems of linear equations, sets of theories, and real numbers.

3. Result and Discussion

Learning mathematics using a scientific method would increase students' environmental knowledge. The scientific approach is called the golden bridge and the evolution of students' behaviours, knowledge, and abilities. Scientific approach implementation consists of five learning experiences: observation, questioning, experimentation, association, and communication. The scientific approach is one form of active learning [15]. Active is required for the advancement of science and environmental issues, as it can indirectly address social and environmental problems as well as environmental effects, including the environmental implications of human behavior [16].

Environmental content is provided during observation. This phase is the beginning of the learning process. This phase is important step in determines the students' mood. If this phase is passed with fun and arouses curiosity, a lot of curiosity in students, the teacher will transfer knowledge very quickly. At this stage, a meaningful learning process is prioritized to fulfil the curiosity of students. If the chosen content is correct, the learning process has a very high meaning.

In the learning phase, there are three main components discussed: the use of the environmental content, enhancement of environmental awareness, and learning design. The three components of learning are presented in detail below.

3.1. Teaching descriptive statistics, data and data presentation

Besides statistical inferences, descriptive statistics are one topic of the statistical method. Descriptive statistics are concerned with applying statistical methods to collection, processing, presentation, and analysis of quantitative data [17]. Descriptive statistics simply describe the numerical processes or graphical methods used for the organization and definition of a given sample 's features or elements. Descriptive statistics are intended to describe the midpoint of the spread of scores, usually referred to as the measure of the central tendency, and the spread of scores known as dispersion or variance [18].

Environmental content used in this instruction is variety of plants growing in the school yard. While issues of environmental awareness that is intended to improve is the students are aware of the benefits of plants in the yard. In addition to its function as aesthetics, plants also act as dust filters and shades. This awareness will further foster a sense of love and care for and protect plants and the environment.

Learning design: Students observe and classify plants that grow in school. Some categories, such as protective plants, productive plants, and ornamental plants, are used. Next, students are searching for information through learning resources, such as the internet, about the Latin names of the plants they list. Students will then count the number of plants based on these classifications. The results of these calculations are shown in the frequency tables, bar charts, and line charts. Students will then present their work, either in groups or individually, to be discussed in class.

Through this learning activity, students are expected to be able to collect and present data in the frequency tables, bar charts, and line charts. Students can also learn about the types of plants that exist in the school environment. When communicating in the form of a presentation, the teacher can ask questions that lead students to think critically—teachers' questions about the benefits of plants and their relationship to air and learning comfort. Next, the teacher links global warming to the flood disaster caused by the declining forest area.

3.2. Teaching algebraic and linear equations systems

The problem commonly found in algebra learning is the lack of students' understanding of algebraic symbols and their meanings [19]. Symbols in algebra are unknown objects, variables, and parameters [20]. Therefore, algebra learning should begin by explaining objects in algebra using different real objects, such as plants, animals, and their parts. For example, areca nuts are used to explain linear equation systems [21].

Environmental content used in this instruction is Papua' agricultural identity, for instance, betel nut (*Areca catechu*). While issues of environmental awareness that is intended to improve: Students are sensitive to food safety and have an innovative character. They will then grow the featured products of Papua transformed into a commercial product that will boost their welfare.

Learning design: The 'para-para pinang' structuring model contains the areca and betel components in one stack. There is also the add lime component in each stack. The areca, betel, and lime components are symbolized by lowercase letters such as a, b, c or x, y, z. The quantity of each component in one stack refers to the coefficient. The teacher can design learning using student worksheets. The student worksheet will provide exercises that help students understand the definition of variables, quantities, concepts, and arithmetic operations.

3.3. Teaching set theory; union, intersection, and complement

Set Theory is one of the essential topics in probability subjects. Probability is one of the subjects in the mathematics education department that has a low graduation rate. Students assume that this course is challenging to understand [22]. It is therefore necessary to develop a variety of learning models. One effort that can be made is to develop a learning design, as described below.

The environmental content used in this instruction is the cultural variety of Papua, including traditional dances, folk songs, and games. While environmental awareness issues are recognized by students and have the character of love and pride through the unique culture of Papua. Culture as the identity of Papua.

Learning design: Learning to use cultural content can be achieved in a variety of ways. If the material of the song is used, this learning is combined with the game. The song "Lemon Nipis" is performed while playing in order to learn the principle of Set. The non-playing group watches a group playing with a song. The emphasis of the study is on the playing technique since it is on that technique that the concepts of the union, intersection, and complement of sets [22]. If the chosen content is difficult to find directly, the teacher may view it in the form of videos such as 'Tumbu Tanah', Mashed Earth' videos. Tumbu Tanah dance is a traditional Arfak dance in Manokwari. This dance is also known as snake dance because the formation of this dance is a snake that wraps its body in a tree. The *Tumbu Tanah* dance is performed at important events, such as welcoming guests, winning the war, and weddings [23].

3.4. Teaching real number and its operation

The real number and its operation are some of the subjects of mathematics. According to Tall and Schwarzenberger, one of the problems with teaching real numbers is the misunderstanding of the concept. Students' misconceptions of real numbers because of the errors of the teacher [24]. Mathematics is an abstract subject, so mathematics teachers should use real objects to explain the concept of actual numbers. In addition to being able to explain mathematical concepts, the use of environmental content in learning can also increase student awareness of the environment.

Environmental content used in this instruction is Papua' featured agricultural product, for instance, sago and sweet potato (*Ipomea batata*). While issues of environmental awareness is students are sensitive to food safety and have an innovative character. They will then grow the featured products of Papua transformed into a commercial product that will boost their welfare.

Learning design: Learning Real Numbers and the operations always use content that is not realistic in the context of Papua. For instance:

1. 2 Apples + 2 Apples = Apples
2. If the price of a kilo of grapes is Rp. 24,000. So, what's the price of 0.7 kg of grapes?

It is not appropriate to use apples and grapes because they are not in the context of Papua. Teachers may replace known objects such as sago and sweet potatoes. After students have understood the concepts taught, teachers can use other objects outside of Papua. It is essential to open students' insights into the use of contexts outside of Papua. One characteristic of the context is that it must be close to students and easy to get, such as straws or objects easily recognized and obtained by students [25].

4. Conclusion

Learning mathematics using environmental concepts, especially biodiversity conservation through a scientific approach can increase student awareness of the environment. This awareness is based on the knowledge and experience of students when interacting with the surrounding environment. In a science-based learning process, there is a process of internalizing environmental conservation character values that will affect patterns of personality and behaviour. Characters that have been embedded in students during the learning process will control their behaviour to create a consistent lifestyle.

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