Diagnostic analysis of student concept in environmental physics

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Abstract. The purpose of this study is to diagnose student concepts in environmental physics courses. This study has used a mixed method. Data has been obtained from interviews, observations, questionnaires, and tests. Study subjects were 78 physics education students who had passed environmental physics courses and 4 lecturers. The results of the study have shown that the chapter in the bad category is the chapter "External factors that influence life on earth". This answered with the percentage of students who answered correctly there were 44.8. And the chapter "Association of physical principles with soil characteristics" is also in the bad category with a percentage of 46.2. This study has been able to provide a description of the material content that is not understood by students in experimental physics subjects, especially related to the concept of physics.

1. Introduction
Students need to understand the phenomena that occur in the environment so they can respond appropriately to changes that occur in the environment. Some phenomena that occur in the environment are very closely related to the principles in physics. students have been able to learn the concepts of physics that exist in the environment, through environmental physics courses. This course has integrated several natural concepts of science (physics, chemistry, and biology) both mathematically and in application in life. This review has made environmental physics courses important to be taught and studied. But the fact is that most students who have attended this course have experienced not understanding the concept of the material as a whole.

Environmental physics courses has provided an overview of how to develop student competencies to understand the environment so that they can "environmental literacy". Some chapters to be analyzed in this study are; 1) The Human, Built, and Urban Environment; 2) External factors that affect life on earth; 3) Observing the Earth's Weather and Cloud Physics; 4) The association of physical principles with soil characteristics, and 5) Environmental Issues for the 21st Century [1]. By the end of this course, a student will be able to: Understand how to apply the basic physics to the human environment, explain the workings of the mechanisms of water transport in the atmosphere and the ground, discuss a specific environmental issue such as pollution, ozone depletion and global warming in the context of an overall understanding of the atmosphere and soil [2]. Students also discuss the problems of energy and understand many other different topics of our environment.
Based on reviews of the importance of Environmental physics courses, the teacher needs to understand which materials are conceptually understood and not understood by students. With this understanding, educators will be able to choose which material is the priority according to the level of mastery of student’s concepts [3]. So the teacher can make improvements to the learning process [4]. Therefore this study aimed to diagnose students concepts in environmental physics courses.

2. Methods
The subjects of this study consisted of two groups. The first group is comprised of students from 78 students. The subjects of this study were selected based on purposive random sampling. The sampling students are students who’ve to take a course in environmental physics. The second group are 4 teachers who teach environmental physics courses. The method used in this study is mix methods, which combine qualitative and quantitative data [5]. Descriptive research design has been used in this study. The instrument used are questionnaire, observation, interview, and test. the questionnaire was given to both groups of the study to find out how the students and teachers on this course. Observations were carried out to learn how the process of learning physics do neighborhood. In-depth interviews do with two groups as the subject. In-depth interviews with a group of teachers on the learning process and how the students’ understanding of the concept of environmental physics. in-depth interviews with students, aimed to find out students' responses to learning. it also aims to clarify students' answers and diagnose their thought processes. The test is given to groups of students who receive 40 questions. The question used is a reasoned multiple choice type [6]. Each question represents an indicator of the achievements of the chapter discussed in the course of environmental physics

3. Results and discussion
Understanding the concept of student views based on the number of questions answered correctly by students. Correct answers in question is the correct answer and supported by the right reasons. Table 1. Shows the student’s mastery of concepts in environment physics course based on the distribution of the chapter. Based on table 1, it appears that there are two chapters that have bad criteria, namely External factors that affect life on earth and the Association of physical principles with soil characteristics. While figure 1 shows percentage of achievement in each chapter in environmental physics. 

Table 1. Student’s concept in environmental physics chapter.

| No | Chapter                                                      | Student’s Correct Answer (%) | Category     |
|----|--------------------------------------------------------------|-----------------------------|--------------|
| 1  | The Human, Built, and Urban Environment                      | 77.9                        | Very Good    |
| 2  | External factors that affect life on earth                   | 44.8                        | Bad          |
| 3  | Observing the Earth’s Weather and Cloud Physics             | 68.4                        | Good         |
| 4  | The association of physics principles with soil characteristics | 46.2                        | Bad          |
| 5  | Environmental Issues for the 21st Century                    | 79.4                        | Very Good    |

Diagnostic analysis results in table 1 show there are two chapters in the very good category and one good category, these two categories will not be discussed in this article. this is because we assume that these three chapters are not problematic. Figure 1 shows that the two chapters are in the bad category, have the same percentage is 14%.
Figure 1. Percentage of achievement in each chapter in environmental physics.

Chapter “External factors that affect life on earth”, students have difficulty understanding how the radiation process occurs and physical modeling of radiation. The one of test is about greenhouse effect as solar radiation effect (e.g. Figure 2. The Phenomenon of The Greenhouse Effect [1]). The fact that the mechanism is in many ways analogous to the way that a greenhouse works and the atmosphere can be considered as a greenhouse roof [7]. The radiation discussed in this chapter is not only related to solar radiation, but also about radiation from radioactive substances [8]. Radioactivity has positive and negative effects as has been proven by several previous studies, one of the positive effects of radioactivity is as an alternative cancer therapy [9]. In otherwise if radioactive substances are used excessively and inappropriately, it will have a negative impact on body health. Improper use, radioactivity can damage healthy body cells too.

The greenhouse effect comes is analogous to the way that a greenhouse works and the atmosphere can be considered as a greenhouse roof. Image of the left hand side (figure 2) is a situation where the temperature is too low. Then the ‘glass roof’ is placed on the ground. Glass allows solar radiation to occur and prevents infrared radiation from being emitted directly into space. this makes the glass roof warmer until it reaches the characteristic temperature \( T_g \) and the glass roof will then radiate back to the ground and out into space. So that the earth receives more energy than before and the temperature rises until it reaches a new equilibrium where the soil and glass roof emit as much as they absorb. In this situation, the upward emission from the glass roof will be the same as the upward emission from the land without a ‘glass roof’. Mathematically can be written \( T_o = T_g \). considering the state of the soil, the net energy given to the ground directly by the sun must be \( \sigma T_o^4 \) and the energy re-emitted from the glass roof must be \( \sigma T_o^4 \). So the equation must be

\[
2 \sigma T_o^4 = \sigma (T_o/4)^4
\]

The ground temperature as

\[
T_o/4 = T_o25 = 298 K(25^\circ C)
\]

This is a simple analogy to the green house effect. Where is the glass roof as an atmospheric model. The glass roof is assumed to do nothing and only pass through solar radiation and completely block terrestrial radiation from the surface [1], this has become the reason why temperatures can increase. On issues related to the greenhouse effect as solar radiation effect 73% students have not successfully overcome the greenhouse effect as the effect of solar radiation, especially. However, in general students have managed to answer well the effects of the greenhouse on the ecosystem and the environment. The mistake that often happens is the depletion of the ozone layer is considered a cause of the greenhouse effect. Some students have even responded to extreme changes and increasing atmospheric CO\(_2\) levels has caused the greenhouse effect.
Chapter “The association of physical principles with soil characteristics”, Most students do not understand that soil has characteristics that be affected by several physical phenomena. Conversely, by looking at physical phenomena, we can also see how the characteristics of the soil. Figure 3 shows one of the questions given to students that causes students’ misconceptions. Students do not understand signal shape of seismic waves that pass a soil influenced also by the characteristics of the soil so the impact on the wave attenuation [10]. Some study suggests that the form of seismic waves that pass a plot turns can be used to determine the characteristics of the soil [11]. Seismic waves propagating in the soil experience signal attenuation caused by the absorption of energy by the soil medium, as a result of the characteristics of rocks and minerals in the soil. This is caused by geometric spread, scattering and intrinsic attenuation. Attenuation is elastic wave propagation which causes energy loss due to shifting of grain boundaries and mineral dislocation.

The Q factor as attenuation formulated as
\[
\frac{1}{Q(\omega)} = \frac{\Delta E}{2\pi E}
\]
Where E is the maximum energy and \( E \) is the energy lost. Starting and final energy measurements are carried out by spatial or temporal decay. So \( E \propto A^2 \) or \( \sqrt{E} = A \). Energy can be expressed as
\[
E = -\frac{\Delta EQ(\omega)}{2\pi}
\]
The formula relationship between attenuation and energy is
\[
A = -\frac{\Delta AQ(\omega)}{\pi}
\]
Amplitude was given by A. Seismic wave images have provided information related to the value of amplitude, frequency and time. so we can calculate the energy decay that has occurred and the attenuation value. the medium absorbs the amplitude of seismic waves depending on the characteristics of the physics characteristic of soil (size, porosity, of the grain, fluid saturation, density, pressure, and fluid viscosity).

Most students have answered incorrectly in questions about attenuation (figure 3). Depth interviews showed that 87% of students did not consider physics characteristic of soil as the cause of wave attenuation. Students have thought attenuation occurs due to wave diffraction events from the waves emitted by each material in the ground. this has correlated with students' low scores as a source of quantitative data. Quantitative data obtained from test scores and questionnaire scores. Students have experienced misconceptions about the relationship between the electrical properties of the soil as a result of the physical characteristics of the soil. This is supported by a study that showed that the characteristics of the soil may determined based on their electrical properties [12]. Some studies use resistivity
geoelectrics to help recognize soil characteristics based on electrical phenomena to determine soil characteristics [13,14].

![Figure 3. Examples of seismic waves that can provide information related to the soil characteristics of volcanoes.](image)

Qualitative data were obtained from observations and interviews. The results of observations of the learning process, shows that the implementation and learning methods used by teachers have influenced the level of mastery of students' concepts. During this lecture Environmental physics was carried out in face-to-face form by examining environmental concepts. The results of observations, questionnaires and interviews have shown that Environmental physics lectures are conducted in the form of face-to-face by examining environmental concepts. The course must be an integrated activity between activities in the classroom and inquiry as outside activities. Activities in the class in the form of discussions about certain topics, discussions are mostly carried out by students, while the teacher acts as a confirmation or clarification. Activities outside the classroom are carried out by students, in the form of exploration in various sources related to the topics discussed in the course. Several other studies have shown that, teachers can control this activity with online based learning. online learning will be more effective if combined with a problem solving model [15]. The use of Android-based applications has also been proven to help students understand concepts [16]. As a reflection of this study teachers need to improve critical thinking skills and creativity of the students. this will have an impact on increasing students' ability to solve problems [17,18].

4. Conclusion
Diagnostic analysis shows that the learning process model used by the teacher has an impact on the achievement of students' concepts in environmental physics courses. Students experience a lot of misconceptions and do not understand the concepts. In this study specifically occurred in especially in the chapter “External factors that affect life on earth” and “The association of physical principles with soil characteristics”.

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