Analysing of pre-service physics teachers critical thinking skills profile in ocean wave energy topic

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Abstract. This research aims to know the profile of the critical thinking skills of pre-service physics teachers in environmental physics lectures specifically the topic about ocean wave energy and its utilization. The sample used was 29 pre-service teachers 6th semester in a university in West Nusa Tenggara - Indonesia. Data were collected using essay tests, interviews, and observations. The test was developed to measure critical thinking skills based on Tiruneh's critical thinking framework. Data were analysed using descriptive statistics. From the results of data analysis obtained that the critical thinking skills of pre-service physics teachers are still relatively low where most of the pre-service physics teachers in all indicators of critical thinking are still at a level below the average. Therefore, learning needs to be developed to equip various skills during the learning process including critical thinking skills.

1. Introduction
Radical changes in various aspects of community life in the 21st century today require careful attention by actors and decision makers in government. False assessing, formulating, and developing policies will have fatal consequences for a country's growth rate. Of all the components and aspects of growth that exist, humans are the most important factor because they are the main actors of various life processes and activities. Therefore, various countries in the world try to define the intended characteristics of human beings in the 21st century [1].

Higher-order thinking skills such as critical thinking, creative thinking and problem solving are necessary skills for 21st century individuals. Critical thinking is one of the skills that underlies the other three thinking skills. This means that critical thinking needs to be mastered before reaching the other three higher-order thinking patterns [2]. Critical thinking is thinking based on appropriate and trustworthy knowledge, or a way of thinking that is reasonable, illustrated, responsible and proficient [3, 4]. In this sense a person is said to think critically when asking a thing and looking for information appropriately. Then the information is used to solve problems and manage them logically, efficiently, and creatively, so that they can make conclusions that are acceptable to reason [5]. Furthermore, the
information is used to solve the problem faced appropriately based on the analysis of information and knowledge in its possession.

Many problems today are caused by uncritical human actions. Environmental damage and suspicion between community groups and even disputes in the community are caused by a lack of critical citizenship which causes many social problems. Thus, mastering critical thinking can help citizens to protect themselves [6]. Therefore, mastering critical thinking skills for citizens can avoid various social conflicts.

Critical thinking can be learned and improved both at an early age and in adulthood. One strategic step that can be done is through the learning process by training and accustoming students to always think critically [7]. In order for the critical thinking process to occur in learning a specific plan is needed for the material, constructs, and conditions. The material in the curriculum should be arranged systematically so that it can be easily assimilated. Constructions aim that students can build their cognitive structures. Conditions are intended so that students learn in accordance with the order to develop cognitive structures and use them in solving problems faced by society.

Teaching students how to think critically is important in education. This is because critical thinking is very important to participate effectively in a democratic society with a set of skills in terms of decision making at work, leadership, clinical judgment that influences professional success [6]. In addition, by mastering critical thinking skills, students can evaluate what is learned in class, helping in discussion. Whereas for teachers the ability to think critically can help to argue well, when giving explanations to students.

Therefore, by knowing the profile of the critical thinking skills of pre-service physics teachers in research, it can be used as a consideration in designing future learning so that pre-service physics teachers are equipped with better critical thinking skills especially in environmental physics lectures [8]. Armed with the ability to think critically to prospective physics teachers through environmental physics, awareness will naturally arise to care and protect the surrounding environment [9]. The importance of mastering critical thinking skills is that students can understand concepts more easily, be sensitive to problems that occur, understand and solve problems that occur around them, and apply these concepts in different situations [10, 11]. By training critical thinking skills during learning as well as teaching students to develop strategies and tactics in order to achieve success in the global competition in the future.

2. Methods
This study is a survey in a university in West Nusa Tenggara - Indonesia. This survey involved 29 pre-service physics teachers in the 6th semester who had taken an Environmental Physics course. Data obtained using essay tests, interview and observation. Questions are designed based on indicators of critical thinking skills in the topic of ocean energy and its utilization. The critical thinking framework used is the Tiruneh framework [12] which consists of reasoning indicators, thinking as testing of hypothesis, analysis of argument, likelihood and uncertainty analysis, problem-solving and decision-making. The example question is:

| Indicator: Argument analysis (Identify key parts of an argument: identify the reasons that support the conclusion) |
| Question: The increase in electricity demand is not in line with the increase in electricity production so that must be found the alternatives to produce electricity so that electricity needs are met. An alternative that can be done is to utilize ocean energy, especially ocean wave energy as a renewable energy source. In your opinion, whether the use of ocean wave energy as an alternative energy source can be the right solution to overcome national energy problems that always depend on fossil energy? Tell your reasons based on Indonesian ocean conditions! |

Figure 1. Example of the question to measure CTS
Data were analysed using descriptive statistics. And to categorize the critical thinking skills in this study is based on the score of the answers to the questions described as presented in table 1.

### Table 1. Level of Critical Thinking Skills

| Level of CTS    | Score  |
|-----------------|--------|
| Superior (S)    | 81-100 |
| Above Average (AA) | 61-80 |
| Average (A)     | 41-60  |
| Below Average (BA) | 21-40 |
| Poor (P)        | 0-20   |

#### 3. Results and Discussion

Based on the data analysis results that obtained from the measurement of critical thinking skills of pre-service physics teachers on the topic of ocean energy and their utilization by referring to the Tiruneh critical thinking framework that the level of critical thinking skills of physics teachers is still relatively low. Overall, of all the indicators of critical thinking, there are no pre-service teachers who are at the superior level. And most pre-service physics teachers have below-average critical thinking skills. For more details, can be seen in figure 2.

![Figure 2. Critical thinking skills (CTS) Profile of Pre-Service physics teacher (P-SPT)](image_url)

Based on figure 2, for reasoning indicators, there are only 10% or 3 pre-service physics teachers who have above average skills and 48% or 14 physics teacher candidates who have below-average critical thinking skills. Many pre-service teachers have below-average critical thinking skills because they have not been able to recognize the ambiguity of the term and evaluate and analyse ideas from various perspectives. In addition, their insights about ocean energy and its use are still very low causing them to respond to questions not in accordance with the expected answers. In line with what Tiruneh [13] stated that reasoning skills are characterized by a person's ability to submit allegations, manipulate, check the validity of an argument, decide the pattern or nature of mathematical symptoms to make a generalization, recognize and identify ambiguous terms.

Furthermore, for critical thinking skills on the indicator thinking as hypothesis testing in figure 2 that the dominant physics teacher candidates are 59% in the category below the average, only 7% who have skills above the average. This shows that pre-service physics teachers’ critical thinking skills in thinking as hypothesis testing is still relatively low. And based on an analysis of the answers and
interviews that the teacher candidates who most of them have not been able to identify cause and effect relationships, recognize the need for further information to make valid conclusions and check the adequacy of observations before drawing conclusions. Similar to what was expressed by [12] that the skills that must be possessed in thinking as hypothesis testing is the ability to identify important relationships or relationships between events, the ability to check the adequacy of experimental observations to draw conclusions and the ability to check adequate sample sizes and possible bias in sampling when generalizing.

In addition, Figure 2 also shows that there are 14% of the number of pre-service physics teachers who have argument analysis skills above the average while the number of physics teacher candidates who have below-average and poor argument analysis skills respectively by 45% and 17% This is due to the low ability of pre-service physics teachers to identify important parts of the argument as well as identifying reasons that support the conclusion and have not been able to give a correct statement from the data set given [14].

The same is true for the skills of Likelihood and uncertainty analysis and also Problem-solving and decision-making indicators as shown in Figure 2 where the number of pre-service teachers with both skills is below average compared to above average. The low skill of likelihood and uncertainty analysis is because the pre-service physics teacher still has difficulty in understanding the probability and likelihood of an event, identifying assumptions and making valid predictions [13]. While many pre-service physics teacher have below-average problem-solving and decision-making skills due to the pre-service physics teacher still having difficulty identifying the best options from a number of alternatives in solving everyday problems, determining the validity of certain scientific explanations when applied to situations new, examine the relevance of procedures in solving problems, use analogies to solve problems, and difficulty developing reasonable and creative solutions to a problem [12].

Another factor that causes the low critical thinking skills in pre-service physics teachers is based on the results of interviews and observations that during the lecture process so far does not equip any skills including critical thinking skills. The learning process is carried out conventionally like making papers independently then presented to the class. In addition, the learning design listed in the lecture program does not reflect the learning that involves certain skills.

4. Conclusion
From results and discussion, it can be said that the critical thinking skills of pre-service physics teachers in the topic of ocean energy and their utilization on environmental physics lectures are still relatively low. The low critical thinking skills on all indicators are because the pre-service physics teacher does not really master the topic of ocean energy and during the learning process, the lecturer does not practice certain skills. Therefore, for the learning process in the future, it must equip a variety of skills in pre-service teachers to produce teachers who are ready and of high quality.

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