Physics education students’ cognitive and affective domains toward ecological phenomena

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Abstract. Environmental education is become prominent in dealing with natural phenomena that occur nowadays. Studying environmental physics will lead students to have conceptual understanding which are important in enhancing attitudes toward ecological phenomena that link directly to cognitive and affective domains. This research focused on the relationship of cognitive and affective domains toward ecological phenomena. Thirty-seven Physics Education students participated in this study and validated sources of data were collected to explore students’ conceptual understanding as cognitive domain and to investigate students’ attitudes as affective domain. The percentage of cognitive outcome and affective outcome are explored. The features of such approaches to environmental learning are discussion through analysis of contribution of cognitive to develop the attitude ecological as affective outcome. The result shows that cognitive domains do not contribute significantly to affective domain toward ecological phenomena as an issue trend in Central Sulawesi although students had passed Environmental Physics instruction for two semester. In fact, inferior knowledge in a way actually contributes to the attitude domain caused by the prior knowledge that students have as ombo as a Kaili local wisdom.

1. Introduction
Cognitive and affective competence are two of the three competencies as outcome learning set by the Indonesian government as a standard of higher education that refers to the Indonesian National Qualification Framework (KKNI) to encourage the realization of character through learning [1]. Cognitive competence involves mental skill as knowledge and development of intellectual skills. Affective competency refers to behaviors that emphasize aspects of feelings and emotions, such as interests, attitudes, appreciations, and ways of adjustment. In other words, cognitive and affective competencies are an attitude, behavior, and action caused knowledge which interconnected and integrated [2-4].

Bloom describes affective taxonomy in five accessible categories: receiving, responding, valuing, organizing, and creating/characterizing. The receiving category indicates the desire to know and care; The responding category indicates a response to active participation as part of its behavior; Valuing involves determining values, beliefs or attitudes and commitments; Organizing refers to the ability to organize attitudes and engage in joint actions; And creating/characterizing is an attitude and commitment;
Organizing refers to the ability to organize attitudes and engage in joint actions; and creating/characterizing is an attitude that is formed into characters [3]. These five categories are actually the level or level of attitude formation process from the lowest level (receiving) to the highest level (creating/characterizing). This character is an attitude of high commitment because it is formed from a series of thoughts (cognitive), effective, and behaviors that become a habit [5].

Cognitive and attitudes can be established through various models or learning methods that encourage student activeness, such as inquiry based learning, problem based learning, project based learning. The results show that inquiry based eco-pedagogy improves students’ cognitive and attitudes in the environmental physics lectures, especially on ecological issues which they familiar it. Known issues can be a prior knowledge for students which sourced from the knowledge of local wisdom. It can distort the cognitive and affective students because sometimes it contradicts to new learning material or is not a knowledge scientifically. Similarly, based learning projects can improve attitudes in physics lectures conducted in the laboratory, and even problem-based learning can improve attitudes and the ability to think critically [4,9,10]. However, cognitive and affective can be formed and developed through appropriate learning through various models and approaches.

Ecological knowledge and attitude are the outcomes in the environmental physics lecture because environmental physics as part of science is related to the understanding of the natural environment, [6, 7], where the principles of physics are applied in understanding environmental problems. The existence of environmental issues as local and global issues, such as global warming, deforestation, and the use of energy resources that are part of the learning of physics, encourage the involvement of all fields to take a position, including the world of education. Therefore, physics education should provide insight into the values of ecological awareness and concern for its natural environment as the actualization of attitudes to a harmonious and sustainable life [8]. A previous research investigated attitudes towards science, the influences as on the attitudes and attitude’s impact [1]. There are also two previous research about cognitive [12] and affective domains [13]. Based on the back ground, the aim of the research is to explore cognitive and affective domains toward ecological phenomena of Physics Education students after passed two semesters of Environmental Physics course. The purpose of this research was to explore and described students’ conceptual understanding as cognitive domain and attitudes as affective domain toward ecological phenomena.

2. Methods

2.1. Research method

A qualitative design used in this research to identify pre-service physics teachers’ learning outcome toward ecological phenomena which is examine percentage of knowledge as cognitive domain and attitude as affective domain. Research was conducted at a university in Palu, Sulawesi Tengah-Indonesia. The respondent of this research is pre-service physic teachers that come from different rural with different home environmental such forest, rural, sea, and lake that passed Environmental Physics course after two semester.

2.2. Questionnaire design

Collecting data using validated questionnaire given to 37 students. This validated questionnaire include 44 multiple choice questions to evaluate conceptual understanding about ecological phenomena and 150 questions that represent ecological issues trends in Sulawesi Tengah. The affective questionnaire consists of five categories which refers to Bloom taxonomy [3] as receiving, responding, valuing, organizing, and creating/characterizing. That questionnaire was arranged in favorable and unfavorable statements with two alternative answers Yes or No.

Ecological phenomena represent ecological issues trends in Sulawesi Tengah which composed global warming phenomena, deforestation phenomena, and using energy resource phenomena.
3. Result and Discussion

3.1. Students’ cognitive toward ecological phenomena

Students’ cognitive represent conceptual understanding about ecological issues that consists of some of ecological subjects as shown in Table 1. All the subjects represent global issues but the questions describe ecological issues trends in Sulawesi Tengah.

| Ecological phenomena | Subjects                                      | Cognitive outcome (%) |
|----------------------|----------------------------------------------|-----------------------|
| Global warming       | Climate change and greenhouse effect         |                       |
|                      | Extreme environment                          |                       |
|                      | Urgency of climate change mitigation         | 69.09                 |
| Deforestation        | Damage to lithosphere                        |                       |
|                      | Damage to hidrosphere                        |                       |
|                      | Damage to ecosystem                          |                       |
|                      | Urgency of deforestation mitigation          | 58.78                 |
| Using energy resources| Environmental pollution                      |                       |
|                      | Electrical energy crisis                     |                       |
|                      | Urgency of green alternative energy          | 67.57                 |

Based on Table 1 were found that percentage of cognitive outcome of deforestation phenomena is 58.78 which lowest than global warming and using energy resources phenomena. It shows that physics education students more understand scientifically the concept of global warming and using energy resources than deforestation phenomena. This finding somewhat contrary to the fact most of the students’ residential environment are rural, forest, lake, and sea. Based on the interviews, there are some of local wisdom which play a role in preserving the forest. One of which is called ombo. Ombo is the local wisdom of the Kaili community about the prohibitions against harm to human harmony with nature such as the prohibition of natural exploitation, alienation of land, illegal logging, excessive hunting, and polluting the river. However, recently there has been degradation of the ombo [11].

3.2. Students’ Affective toward ecological phenomena

Based on the study that had been conducted on 37 Physics Education students, percentage of affective on each category showed in Table 2. The means percentage for global warming phenomena was 53.95, deforestation was 83.89, and deforestation was 54.76 respectively. As can be seen, the percentage for deforestation greatest than two the other aspects of ecological phenomena. This shows that students are more able to be friendly to the forest than to the phenomenon of global warming and the phenomenon of the use of energy sources. This may be due to the local wisdom - ombo - that is maintained in the community in which they live, in addition to because the students have been accustomed to living in harmony with the forest environment.

| Ecological Phenomena | Affective categories | Means |
|----------------------|----------------------|-------|
|                      | Receiving            | 78.97 |
| Global warming       | 78.97                |       |
|                      | Responding           | 45.34 |
|                      | Valuing              | 54.36 |
|                      | Organizing           | 67.87 |
|                      | Creating             | 53.16 |
|                      |                     | 53.95 |
| Deforestation        | 82.43                |       |
|                      | 54.05                |       |
|                      | 68.47                |       |
|                      | 78.83                |       |
|                      | 65.24                |       |
|                      |                     | 83.89 |
| Using energy resources| 74.78                |       |
|                      | 62.17                |       |
|                      | 64.47                |       |
|                      | 59.46                |       |
|                      | 60.05                |       |
|                      |                     | 54.76 |
| Means                | 78.73                |       |
|                      | 53.85                |       |
|                      | 62.43                |       |
|                      | 68.72                |       |
|                      | 59.48                |       |
Nevertheless, the average percentage of attitudes by category as can be seen in Table 2 shows that the receiving category (78.73) is the highest compared to the other attitudes category, while the lowest is the responding category (53.85). These results illustrate that students’ affective toward environmental issues in Central Sulawesi are in the receiving category only. Based on Bloom, receiving category is a category of attitude that illustrates that the students are limited to knowing and have not done anything. This receiving category result is supported by the lowest responding category, followed by creating or characterizing category (59.48) depicting actions that are characters. Thus, it can be mentioned that the attitude of physics education students to the environmental phenomenon has not reached action in response to environmental issues surrounding them.

![Figure 1. Percentage of Affective on each category](image)

Based on Figure 1 it can be seen that there is no significant difference of student attitude toward global warming, deforestation, and using energy resources issues. But overall, the average percentage of all three ecological phenomena is seen to be a significant difference in which the deforestation issues are the most understandable environmental issues.

3.3. The relationship of cognitive and affective domains toward ecological phenomena

Education is an important thing that should be done in order to response every challenge on current situation and the future. The outcome or competency of learning can be achieved through learning that change of behavior through real experiences [10]. It means that ideally cognitive domain have an effect to affective domain. Opponently, Figure 2 showed that almost no effect cognitive through affective although students had passed Environmental Physics instruction for two semester.

| Ecological phenomena     | Cognitive outcome | Affective outcome |
|--------------------------|-------------------|------------------|
| Global warming           | 69.09             | 53.95            |
| Deforestation            | 58.78             | 83.89            |
| Using energy resources   | 67.57             | 54.76            |
| Means                    | 65.15             | 64.20            |
Based on educational achievements set by KKNI covering three domains, namely cognitive, affective, and psychomotor or skills, it is understood that there is an integrated linearity between cognitive and affective. In other words, if the cognitive domain is high then the affective domain is also high, vice versa. Understanding environmental phenomena scientifically contributes positively to the formation and development of a scientific attitude. In fact, inferior knowledge in a way actually contributes to the attitude domain caused by the prior knowledge that students have as ombo as a Kaili local wisdom. Ombo itself are the wisdom of preserving the neighborhoods, protecting the particular animal and plant, preserving the forest and sea, preserving the spring and watershed, protecting the society and indigenous area, and preventing the plague [11].

4. Conclusion

Based on that describing and discussion above, it can be concluded that cognitive domains do not contribute significantly to affective domain toward ecological phenomena as an issue trend in Central Sulawesi. In fact, inferior knowledge in a way actually contributes to the attitude domain caused by the prior knowledge that students have as ombo as a Kaili local wisdom. Therefore, it is very important to consider the knowledge of local wisdom in building an ecological attitude.

5. References

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