Profile of scientific reasoning skill and ecological intelligence of pre-service biology teacher

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Abstract. This study aims to determine the profile of students' scientific reasoning and ecological intelligence skills. The research method used is mixed methods with good performance by using both quantitative and qualitative analysis. The design used in this research is embedded design. This study includes a validator consisting of material experts and learning device experts, 1 high education practitioner, and experiments with a sample of 20 students. The instruments used include questionnaires, observations, interviews, and tests. The experiment used a class of 20 students. Data analysis and processing techniques used during the research are descriptive analysis, percentage technique, and independent sample variable test. The procedure in this research is to do the necessary things in the execution of research such as preparing questionnaire format, observation, teacher and student interview, and experiment with pretest and posttest for scientific reasoning skill and ecological intelligent on learning environmental knowledge. Data collection through interviews, observation and documentation, and test result data. The result of the research shows the profile of students' scientific reasoning ability in the biology education program of the University of Muhammadiyah Bengkulu, including deductive and inductive reasoning with the percentage of "good" category achievement of 73% and the proficiency profile of ecological intelligence of "excellent".

1. Introduction

Thinking is a privilege possessed only by humans that no other living being possesses. Thinking is manipulating data, facts, and information to make decisions behave. Many people have not developed the thinking ability they have, including the ability of scientific reasoning. Scientific reasoning skill is the correlation between the theoretical ability and the new hierarchy of a concept [1]. In other studies, reasoning skills are derived from the thinking process of individual reasoning and collaborative cognition through a problem-based learning model[2]. The process of reasoning skills from time to time has evolved, along with advances in the field of science and technology. Scientific reasoning can be linked with the strengthening of one's self-confidence, especially in the field of science, the relationship with addressing the phenomena or myths that occur in the community.

Building a human consciousness to conserve the environment is very important today. This is because at this time the reality shows that human consciousness to the environment with various forms of behavior reflects their ignorance of the environment. The low human
awareness of this environment occurs in almost all circles, both in the upper middle class and the middle to lower class. The reality of such conditions reinforces the notion that care and awareness in preserving and protecting the environment is critical and urgent to do. Human awareness of the environment is not only to create beauty or hygiene, but it has also become a human obligation to respect human rights, nature, and life. The right of man is to enjoy and feel the balance of pure nature, so there is harmony with nature. Such cultural values are expected to be built through the restatement of local wisdom that can ensure environmental sustainability. The problem we face today is the low level of human awareness of the environment that causes ecosystem damage.

This shows that our society has a very low Ecological Intelligence, because ecological intelligence actually requires humans to apply what they experience and learn about the relationship of human activity with the ecosystem. Ecological intelligence forge people to be part of an ecosystem that organizes emotions, thoughts, and actions in addressing the universe. Ecological intelligence is poured in the form of real attitudes and behaviors that take into account ecological capacity, and give birth to the faithful attitude of human friends with nature[3]. The universe is not only a source of exploitation, but also as a shared living house that is protected, nurtured, and organized, instead of being destroyed.

Therefore, points out the need for the development of ecological intelligence in relation to an understanding of the benefits and potential threats behind all products of civilization [4]. The concept of ecological intelligence is not only interpreted as the ability of rural populations (indigenous) who are adept at observing the environment, but also includes an understanding of science whose principles are applied to understanding natural systems ranging from small to global. Ecological intelligence allows us to understand the system in all its complexities, as well as the linkage between nature and the manmade world. The term ecological intelligence [5], is defined as "ecologically oriented local wisdom." Currently, ecological intelligence needs to be built not only at the individual level but also must be developed into collective intelligence and awareness together especially on learners at the elementary, junior high school, high school level and even up to university level.

Based on the above explanation, the researcher got the idea with novelty and originality which was implemented into the research entitled "Profile of Scientific Reasoning Skill and Ecological Intelligence of pre-service biology teacher". Researchers hope this article will increase innovation and creativity for teachers, especially science education teachers on aspects of scientific reasoning and ecological intelligence.

2. Method
The method used in this research is mixed methods [6] with good performance by using both quantitative and qualitative analysis. The design form used in this study is embedded design. Characteristics of embedded design (inserting design) is a mixed-method design in which a data set provides support to another data set that becomes a role in the main study. In embedded design, quantitative data will be embedded for treatment development purposes, to test the intervention process or to follow up on the learning outcomes. This research involves a validator consisting of material experts, teaching device experts, high education practitioners, and experimental classes implemented on 20 students. The instruments used include questionnaires, observations, interviews, and tests. The experimental class of learning activities uses a class consisting of 20 students. The class is given the same treatment, which is giving the problem of scientific reasoning and ecological intelligent through pretest and posttest. Data analysis and processing techniques used during the research are descriptive analysis, percentage technique, and independent variable sample test. Implementation of the research procedure is to do necessary things in the implementation of research such as
preparing the questionnaire format, observation, interviews lecturers and students, and experiments with pretest and posttest for scientific reasoning and ecological intelligence skills on learning environmental knowledge. Data collection through interviews, observation and documentation, as well as test result data. The selection of classes is done on the consideration of the number of students, characteristics, and ability of individual students who are considered equivalent. The design of this study is presented in Figure 1 below:

The preferred approach is a sequential approach that is a two-phase approach. In this approach, data collection and analysis is performed before, during, and after intervention. This sequential approach of data analysis is done before, during and after intervention. This research begins by determining the population and selecting samples from the existing population. Samples will be taken two classes, that is given the treatment of scientific reasoning and course program implemented in the even semester by means inserted in Science Education courses. The stage of research implementation is as follows:

1. Qualitative Research Before Intervention. Students are given a perception questionnaire about the learning process of environmental knowledge that has been implemented. Semi-structural interview with lecturers and students to know the description of the implementation of the lecture of environmental knowledge that has been done.

2. Qualitative Research During Intervention. Conducting observations on the lecture of
environmental knowledge. Semi-structural interview (one on one semi structure interview) in some lecturers to get information about difficulties experienced during the course of environmental knowledge.

3. Quantitative Research During Intervention. Provision of pretest and posttest of reasoning ability as well as giving pretest and posttest ecological intelligence.

4. Qualitative Research After Intervention. Providing questionnaires to find out the students' perceptions of the lecture of environmental knowledge.

Instruments used in this study.

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To know the profile of scientific reasoning ability and ecological intelligence, it is necessary to do technique and data processing as follows:

a. Analysis of Validity
   The test instrument is tested for validity by using the product moment correlation technique proposed by Pearson (Pearson Product Moment).

b. Reliability Test Analysis
   The reliability value of the instrument obtained from the calculation is interpreted using the degree of reliability of the instrument[7].

c. Normality and Homogeneity Test
   Normality test is used to determine statistics to be used in data processing, the most important is to determine whether using inferential statistics will be data. To test the normality of sample data obtained are pretest, posttest and scientific reasoning and student's ecological intelligence.

d. Improvement Determination (N-Gain)
   The determination of the extent to which student competence increases as a result of the treatment is analyzed by determining the normalized Gain as used[8].

e. Descriptive Analysis
   Student perception questionnaires using Likert’s four rating scale, the interval range is the ideal score (criterion) for all items minus the minimum score and the result is divided by the class response interval.

3. Result and Discussion

3.1 Reasoning ability test
   The reasoning skills test is performed using the Lawson Classroom Test. Scientific Reasoning consists of 12 questions. Students who are rated 0-4 are grouped at concrete
operational level or are at low reasoning skill level, 5-8 are grouped at the transition level or are in moderate reasoning skills, and 9-12 are grouped at the formal operational level categorized in skills high-level reasoning. Based on the level of reasoning results then the students are grouped based on the level of reasoning can be seen in Figure 2.

![Figure 1. Figure Scientific Reasoning Skills](image)

The graph shows the percentage of students in each category of low, medium, and high reasoning skills. It is generally seen that the classification of low reasoning skills has a percentage of 11%, while the percentage of student achievement in moderate reasoning skill category is 73%. The category of high reasoning skills has a student percentage of 16%. Student reasoning skills are still very low, because in the learning process, especially in group discussions, many still work individually. This is in accordance with opinion, that reasoning skills are derived from individual thought processes and collaborative cognitions through a problem-based learning model [9]. In addition, based on the analysis of journal articles that have been done, the reasoning ability can be improved through the application of several learning models such as inquiry [10], Problem Based Learning [11], ICT-based [12], play and group discussions [13]. In other research contexts, in addition to the application of learning models to the enhancement of reasoning abilities, it can also be the correlation of reasoning to the mastery of concepts [14], achievement [15], logical thinking [16]. In the context of other studies, in addition to the application of learning models to improve reasoning ability, it can also be a correlation of reasoning to the ability of ecological intelligence.

3.2. Ecological intelligence ability of pre-service teachers

The achievement of the Ecological intelligence profile was analyzed using student value document analysis in the academic year 2017/2018. The data is categorized by percentage of the number of students who get A, B, and C, as shown in Figure 3 below:
Figure 1. Student's ecological intelligence ability

From the results of questionnaire and questionnaire analysis, the outline of the findings. Content dimension, "understanding environmental issues from the perspective of ecological balance and ecological sustainability". The process dimension, "implements in practical and effective actions in applying an understanding that is concerned about ecological balance", and the content dimension, "give attention, empathy, and respect to others and other living beings". Table 1 shows excellent results, out of ten content questions used to find out the extent to which the students' ecological intelligence level, most of them can answer correctly, there are only a few students who are not good at answering.

Ecological Intelligence is a material that certainly requires the ability of students to understand understanding the meaning of the material. This is in accordance with the statement, the mastery is the understanding or the ability to use or know, another opinion states that mastery is the process of developing all kinds of knowledge and technology [17].

4. Conclusion
Based on the research that has been done, it can be concluded that in the study of environmental knowledge that has been done to see the profile of scientific reasoning and ecological intelligence, obtained percentage score achievement of science reasoning ability of 73%. The conclusions for the Ecological Intelligence profile of pre-service biology teacher are quite good, from the three dimensions measured: content, process, and attitude. In the content dimension, almost all can answer well, there are only a few students who are not good in answering, as well as in other dimensions such as process and attitudes dimensions. Students as pre-service teachers can respond to the circumstances that occur around the environment, and showed a good attitude and aware that Ecological Intelligence is important to be implemented.

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6. References


[5] Chen, Chun-Ting and She, Hsiao-Ching 2014 *J. Science and Mathematics Education* 20 1Y20


[11] Chen, Chun-Ting and She, Hsiao-Ching 2014 *Journal Science and Mathematics Education* 20 1Y20


[16] Bou J, Salloum, and El-Khalick 2004 Relationships between selective cognitive variables and students ability to solve chemistry problems*International Journal of Science Education* 26 (1) pp 63-84