Correlation of the logical thinking with mastery concept of prospective biology teachers

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Abstract. This study aims to determine the description of logical thinking and mastery of concepts, analyzing the relationship between the two owned by a number of prospective biology teachers in the vertebrate zoology practice. The research method was a correlational descriptive method with a sample of one class which includes 26 prospective teachers of the Department of Biology Education, FKIP Universitas Muhammadiyah Sukabumi (UMMI), 2017/2018 semester academic year using a purposive sampling technique. Data collection was conducted using the many as 10 standard Test of Logical Thinking (ToLT) and 20 concept mastery questions. Data analysis was carried out through a correlation test. The results showed that: 1) 35% of students had logical thinking at the transition stage with an average value of 3.0; 2) 31% of students show mastery of concepts with enough categories with an average value of 63; 3) There is a moderate correlation between logical thinking and the mastery of the concept of prospective teachers with a correlation coefficient of 0.541. The understanding of the highest correlation at each indicator of logical reasoning compared to other cognitive aspects.

1. Introduction

Biology is one part of natural science that has a related influence on mastering science and technology, also plays an important role in efforts to prepare quality human resources. Biology learning requires the active role of students because biology is a scientific process based on logical thinking based on supporting facts [1]. Logical thinking is needed by a person during activities in making decisions, drawing conclusions, and doing problem-solving.

In the 21-st century, logical thinking is one of the competencies that need to be improved. This ability is one aspect of the cognitive domain of science that has not been effectively implemented in learning and teaching. Learners with a good level of logic can change their alternative conceptions more easily [2]. Logical thinking skills are included in formal reasoning abilities. Inhelder & Piaget [3] suggest that logical thinking skills include five types of reasoning namely proportional, variable control, probability, correlational, and combinatorial. Proportional reasoning is important in the quantitative aspect, especially for understanding the derivation and use of a large number of functional relationships, such as the development and interpretation of tabulation and graph data. Correlational reasoning plays a role in the formulation of hypotheses and data interpretation that need to consider relationships between variables. Control of important variables in planning, implementation, and
interpretation. Interpretation of data from findings, observations, or experiments often requires probabilistic reasoning. Combinatorial reasoning occurs in the formulation of alternative hypotheses to test the effects of selected variables.

The logical thinking test (TOLT) of Tobin and Capie [4] which has been used by Valanides [5] is a test to determine the intellectual development of prospective teachers before and after learning. This test is also used to identify three types of reasoning that prospective teachers have based on Piaget's theory which includes thinking of concrete operations, transition thinking, and thinking of formal operations [4].

Logical thinking is one of the important thinking skills and needs to be developed from elementary school to college [6]. In LPTK that produce prospective teachers, these skills need to be trained to equip them later in the field. In some discussions of the term, logical thinking is often exchanged with logical reasoning, because both contain several similar activities. In fact, the term logical thinking has a broader scope than logical reasoning. Logical thinking is an activity to solve problems, both mathematical problems or other problems found in daily life rationally and can be accepted by everyone. Logical reasoning is the reason or explanation given by someone about how to draw conclusions from the available premises based on certain inference rules [7].

The experts stated that logical thinking skills are positively correlated with mastery of concepts possessed by students. In the process of learning science, mastery of concepts is very important and must be the focus of attention [8]. However, a good learning process not only conveys information about the concept but also takes into account the process of delivering the concept. The results of field observations in vertebrate zoology practice, learning that is done tend to emphasize more students on activities to verify concepts so that they do not train the ability to analyze a problem that can develop the thought processes possessed by their thinking. Therefore, the understanding of 21st-century learning is a demand for LPTKs as producers of prospective teachers to implement competencies not only focused on mastering the content of the main courses, but also academic content at a higher level. The existence of these findings requires the importance of the analysis of the relationship between the ability of logical thinking and mastery of concepts in vertebrate zoological practice so that it can be known how likely the correlation values obtained from the two relationships. Based on the results of the analysis, further improvements can be made in subsequent learning.

2. Methods
This descriptive correlational method aims to find out the description of logical thinking and mastery of concepts, analyzing the relationship between the two owned by a number of prospective biology teacher students in vertebrate zoology practice. The subject of the study included 26 prospective teachers of the Department of Biology Education, FKIP Universitas Muhammadiyah Sukabumi in the 2017/2018 school year using a purposive sampling technique. Data on students' logical thinking abilities were measured using 10 questions of logical thinking (ToLT) developed by Tobin and Capie [4]. Meanwhile, the concept of student mastery of data measured by the 10 multiple choice questions, five questions short stuffing, and 5 essay questions related materials that include vertebrate zoology cognitive dimension Bloom taxonomic revision of the level of C1-C6. Scores result of logical thinking is used to classify students into three types of reasoning developed Piaget [9]. The type includes concrete (score 0-1), transition (score 2-3) and formal (score 4-10). In addition, data is processed using rules mastery of the concept of the ideal score. Furthermore, both the data were correlated using the correlation test by SPSS 24 for windows.

3. Result and Discussion
The results of the data analysis related to logical thinking student teachers showed that 35% of 26 students, including transitional stage categories. The average value of student logical reasoning is 3.0. The results of the normality test showed show that students' logical thinking data are normally distributed with a significance value of 0.116. The general description of student logical thinking is
based on three types of Piaget’s reasoning [9] can be seen in Figure 1.

Figure 1. Overview of Logical Thinking Ability Students

In Figure 1 it can be seen that the largest percentage of student logical thinking was found in the transition stage reasoning (35%). In addition, 34% of students have formal reasoning and 31% concrete reasoning. If someone is at the formal reasoning stage, it has significant value on biology, physics and chemistry subjects [10]. Conversely, students who are at a concrete stage will experience difficulties if faced with problems that require formal reasoning [11]. Students with high logical thinking skills will find it easier to build concepts and can change alternative conceptions. This is one of the factors that cause the learning outcomes to be better.

The variation in percentage gains from the stages of students' logical thinking skills shows that the level of a person's development varies in addressing a problem. One of the causes of differences in logical thinking skills may be due to the difference in the environment that affects the development of each student. This is consistent with the statement of Wiji et al. [12] that students' logical thinking ability is not the same and certainly depends on the environment that shapes it [13]. The ability to think logically is related to the level of mastery of student concepts obtained. The results of data analysis showed that 31% showed mastery of concepts with enough categories, 19% showed mastery of concepts with excellent, good, and poorly categories, and 12% showed fewer categories. The average value of conceptualization obtained by students is 63. The results of the concept mastery analysis can be seen in Figure 2.
The finding of the distribution of concept mastery in Figure 2 above showed that the uneven percentage obtained by students on vertebrate zoological concepts is due to their logical thinking abilities. In general, mastery of student concepts is in a sufficient category of 31%. This indicates that there are still many students who have not been able to analyze and explain concepts with their own logic. Though mastery of concepts is the result of a learning process that is indicated by the ability of students to analyze and explain concepts in their own language [14]. The relationship between logical thinking and mastery of student concepts was analyzed using the correlational test using SPSS 24 software for Windows. The test results can be seen in Table 1.

**Figure 2.** Distribution of Students the Concept Mastery

Table 1. Logical Thinking Ability relationship with Concept Mastery

| Logical Thinking | Concept Mastery | Logical Thinking Pearson Correlation | Concept Mastery Pearson Correlation |
|------------------|----------------|--------------------------------------|-------------------------------------|
| Logical Thinking | Pearson        | 1                                    | .541**                              |
|                  | Correlation    |                                      |                                     |
|                  | Sig. (2-tailed)|                                      |                                     |
|                  | N              | 26                                   | 26                                  |
| Concept Mastery  | Pearson        | .541**                               | 1                                  |
|                  | Correlation    |                                      |                                     |
|                  | Sig. (2-tailed)|                                      | 0.004                               |
|                  | N              | 26                                   | 26                                  |

**. Correlation is significant at the 0.01 level (2-tailed).

Table 1 showed that the correlation coefficient value is 0.541 which was a moderate correlation relationship and a significance value of 0.004. This means that there is a positive correlation between the ability to think logically and mastery of the concept of prospective teacher students. The existence of this finding is in line with Yenilmez's research [15] that students with high concept mastery results also have high TOLT scores. The results of the correlation on each indicator of reasoning in logical thinking with the cognitive dimension of mastery of the concepts obtained can be seen in Table 2.
Table 2. Correlation of Indicators of Logical Thinking with Cognitive Aspect of Mastery of Concepts

| Indicators       | Knowing | Understanding | Applying | Evaluating | Analyzing | Creating |
|------------------|---------|---------------|----------|------------|-----------|----------|
| Proportional     | .647**  | .791**        | .641**   | .545**     | -.328     | .293     |
| ControlVariable  | .365    | .505**        | .619**   | .244       | -.228     | -.497**  |
| Probabilistic    | .256    | .389*         | .365     | -.143      | -.314     | -.051    |
| Correlational    | .379    | .503**        | .129     | .457**     | .468*     | .453*    |
| Combinatorial    | .291    | .397*         | .275     | .82        | .300*     | .390*    |

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Table 2 showed in general every indicator of logical thinking can be positively correlated with the cognitive dimension of mastery of concepts. The understanding aspect is one that has the highest correlation at each indicator of logical reasoning when compared to other cognitive aspects. Understanding of concepts correlates with proportional reasoning, variable control, probabilistic, correlational, and combinatorial. This shows that someone who has a logical thinking ability can be helpful to understand the concept in science. With logical thinking, the students solve problems by carrying out various mental practices or reach principals or rules by executing some abstraction and generalization [16]. In accordance with Hackling, to be successful in science and understanding the concepts of directly associated with formal reasoning skills [17]. Furthermore, it was stated that conceptual understanding in logical thinking helps students to identify and correct their misconception. Meaningful science of encompassing the scientific concept and cognitive skills [18].

In addition, the cognitive dimension of creating has a high relationship with combinatorial reasoning. Combinatorial reasoning abilities indicate that in the formulation of alternative hypotheses in testing the effects of variables selected. In this case, students when working on the masters of concepts have the answers to the right answers to the question of mastering the concept. According to Adaptation & Definition definition combinatorial reasoning, the process of creating concepts out of a given set of elements satisfies the conditions of application given or inferred from the situation [19].

4. Conclusion
The ability to think logically prospective teachers of biology at the Universitas Muhammadiyah Sukabumi (UMMI) is 35%, which is include in a transition phase with an average value of 3.0. As much as 31% show sufficient mastery of concepts with the category with an average value of 63. The values correlation coefficient of 0.541 which indicates moderate correlation and significance value of 0.004. This means that there is a positive correlation between the ability to think logically with a
mastery of the concept of student teachers. Besides that, the understanding of the highest correlation at each indicator of logical reasoning compared to other cognitive aspects.

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