The profile of logical thinking biology prospective teachers

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Abstract. Certain program in practical work or lecture often 100% achieved but the achievement result seems still very low. The variety of student backgrounds in a private LPTK also worsened the situation. Therefore it was important to detect first their logical thinking ability as their background or their position in intellectual development before they joint certain courses. This preliminary descriptive study was conducted to investigate the logical thinking ability and scientific reasoning level of prospective teachers at two universities in the area of kopertis VI academic year 2016/2017 (n=84). The data on logical thinking was collected through the standardized Test (TOLT) that had been validated for students from middle school up to doctorate degree. The research finding shows that about 38% of the respondents were still in the concrete operational level, 29% in transitional level, and only 33% in formal operational level. In general, all indicators of students' logical thinking ability can be revealed by the test with different percentage values. This condition explains why most of the prospective biology teachers at a private university in the area of kopertis VI have difficulties in learning abstract biology concepts, and that this conditions should be handled through direct activities (hands-on) in programs.

1. Introduction
The government realizes that every human being has different ability in the learning process. Therefore education becomes a conscious and planned effort to realize optimal learning process for each learner. A good education will be able to see the different abilities of learners, especially from the development of the ability of the thinking process. The higher ability of a person to think in an abstract way, the higher ability of the person will function effectively in the society [1]. In other words, the more one is able to think abstractly, the more capable one is to function himself well in his society. The higher a person's ability to think, the easier it is for the person to understand the problems and solve them with the right solutions.

The student's difficulty in understanding this abstract concept is related to the intellectual development of students [2]. In Piaget's cognitive development theory, cognitive development is divided into four levels, namely: (1) Sensory-motor stage (0-2 years); (2) preoperational thought stage (2-7 years); (3) Concrete operation stage (7-11 years); and (4) Formal operation stage (11-15 years). In sensory-motor stage was characterized by a child is not too conceptually minded, preoperational thought stage was characterized by the development of language skills, concrete operation stage was characterized by a child begins to learn to solve problems with logic but only for concrete problems, and formal operation stage was characterized by a child begins to learn to solve every problem both concrete and abstract using his logic. A child whose cognitive development has reached formal
operational level will more easily solve problems in the learning process. This is because he has been able to use his mind to solve concrete and abstract problems in a logical and systematic way. It is believed that formal reasoning that characterizes formal levels of operation is very important for a child to succeed in science and vocational. Some other researchers claim that the students' formal reasoning ability is an indicator of student success in mathematics and his science [3, 4]. The ability of formal thinking is very students need a variety of learning that requires the activeness of students in thinking, especially in solving problems given. Therefore, improving students' formal thinking ability in the form of formal reasoning is very important to understand various abstract concepts of biology well.

Knowledge of students 'formal reasoning in learning makes it very important to be able to see students' ability to learn. Thus, the knowledge of formal reasoning should be before the start of learning becomes very important to consider the form of learning strategy to be applied. Related to this then tested an instrument that can measure students' formal reasoning ability. Instruments capable of measuring the students' formal reasoning which includes all reasoning are arranged in the form of Test of Logical Thinking (TOLT) [5].

2. Method
This descriptive research was carried to find out the description of logical thinking ability and scientific reasoning level which is owned by 84 Biology student candidates in two private universities of Kopertis IV Region Academic Year 2016/2017. The students' logical thinking ability data was obtained through a written test using the 10 logical Thinking (TOLT) instrument developed by Tobin and Capie [5]. The test data obtained were then analyzed using the Valanides rule to determine the grouping of students' scientific reasoning level [6]. The scientific reasoning category based on TOLT scores obtained by students can be found in table 1.

| Score | Scientific Reasoning |
|-------|----------------------|
| 0-1   | Concrete operation   |
| 2-3   | Transitional         |
| 4-10  | Formal operation     |

In addition, the scores were also analyzed in relation to the achievement of each indicator of logical thinking ability by percentage technique and subsequently categorized based on the Arikunto formula [7, 8].

3. Result and discussion
In obtaining data on logical thinking ability, it is used the logic thinking test (Test of Logic Thinking) developed by Tobin and Cape [5]. The questions in this instrument are capable of measuring the students' formal reasoning which includes all reasoning. The problem has been converted into the Indonesian language to facilitate students in the process. The result of data analysis of student's scientific reasoning level based on logical thinking ability test can be shown in table 2.

| Scientific Reasoning Level | Number of students |
|----------------------------|--------------------|
| Concrete operation         | 32 (38%)           |
| Transitional               | 24 (29%)           |
| Formal operation           | 28 (33%)           |
Table 2 shows that the students' scientific reasoning level have different percentages. Almost half of the students are still at the level of concrete operational thinking (38%). At this level, it is characterized by an increasingly less egocentric way of thinking and becoming more desirable. Someone who has gained some sense (by classification, conservation, and series) and learning how they should apply that understanding in everyday life [2]. Almost half of the students are still in transitional thinking level (29%). This shows that they still think subjectively and think quantitatively which is characterized by naive and often fluid student thinking in quantifying the problem. At this transitional level, one can define the problem thoroughly but not systematically so that in determining the different permutations and combinations it is necessary to first seek information but sometimes not thoroughly [9].

At the level of formal operational thinking, only about half of it already has that level of thinking (33%). Whereas for college, students' logical thinking should be at the level of formal operational thinking. At this level, one can use concrete operations to form more complex operations. One's progress during this period is that he does not have to think with the help of concrete objects or events, he has the ability to think abstractly [10]. The existence of these findings is very contrary to the theory of Piaget's cognitive development which states that a person aged 11 years and over should have had the ability to think at a formal operational level. At this stage, one has begun to learn to solve every problem both concrete and abstract by using logic [2]. The result of Rakhmawan's research found that a person whose cognitive development has reached the formal level of operation will more easily solve problems in the learning process so that he has been able to use his or her mind to solve concrete and abstract problems logically and systematically [11].

In this study also revealed about the picture of information related to student achievement of logical thinking ability indicators through the logical thinking test (Test of Logic Thinking) developed by Tobin and Cape [5]. The result of analysis of logical thinking ability of each indicator is shown in Figure 1.

![Figure 1. Percentage of student logical thinking ability indicators.](image)

In the table shows that student achievement of combinatorial and proportional reasoning indicator has a higher percentage compared to other indicators. In the combinatorial indicator, the student can get a percentage value of 85% (very good). At this stage, they are able to extricate themselves from the reality that can be observed and touched directly. Thought has entered into a logical world that applies absolutely and universally. Piaget suggests that in combinatorial thinking, one will do something systematically [2].

In proportional thinking indicators, students get it as much as 72% (good). This indicates that the student has the ability to work with the quantitative nature of a subject. Lawson revealed that students who have proportional reasoning have the ability to solve problems in proportion and combine the proportions with each other [12]. Meanwhile, for correlational reasoning indicator has percentage value as much as 47% (enough), probabilistic reasoning and control variable has less category with...
different percentage value that is equal to 23% and 38%. In the probabilistic reasoning indicator, the students get the lowest score. Whereas in this indicator, students are required to conduct thinking activities in solving problems through various trends. Probabilistic reasoning occurs when a person uses the information to decide whether a conclusion is true or not [13]. The indicator of this reasoning is shown if one can distinguish between certain things and possible things from the calculation of opportunities.

The ability to think logically is part of the ability to think the reason is not a static ability that was born. This ability develops according to the factors that influence it. One of the factors that can influence the development of students' scientific reasoning is the approach and method of learning science used [14]. The lack of scientific reasoning ability possessed by prospective biology teacher students is possible because the science learning received by students from high school to college has not maximally involved them in the scientific process, but more focused on the knowledge aspect only. Learning biology conducted by teachers or lecturers has not been maximally oriented to approaches and scientific methods. Therefore, it is only natural that they have difficulty in studying abstract biological concepts. This condition should be overcome through direct learning activities (hands-on) in the lecture.

4. Conclusion
The logical thinking ability of students in biology teacher candidates at private universities in the Kopertis VI region is still at the level of concrete operational thinking. The proportional reasoning indicator is the highest indicator achieved by the student in his logical thinking ability. Therefore, it is necessary to improve the students' logical thinking ability through direct and hands-on learning activities in teaching abstract biology concepts.

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