Mapping the reasoning skill of the students on pressure concept

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Abstract. Reasoning skill is one of the high order thinking skill which is needed to accomplish the problems in a logical and coherent way. To measure this skill, the researcher adapted the Lawson’s Classroom Test Scientific Reasoning (LCTSR) on pressure concept. There are six aspects related to the reasoning skill that were measured. They are conservation reasoning, proportional reasoning, controlling variables, probabilistic reasoning, correlational reasoning, combinatorial reasoning. The aim of this study is mapping the reasoning skill of the students on answering the test of pressure concept. The research method chosen in this study is descriptive method. This test consist of 12 pairs multiple-choice questions with the pressure content and the reason. The test was employed to 60 students at IX grade of junior high school the academic year 2017/2018. The findings of this study showed that 60% of the students achieved level 1 (concrete operational), 33.3% achieved level 2 (transitional operational) and only 6.7% of them achieved level 3 (formal operational). It means the reasoning skill of the student was low. In order that, mapping the reasoning skill of the student can support the educators to prepare and implement teaching effectively.

1. Introduction
High order thinking skill can be developed by science learning. Science learning have a huge potential and strategies role in preparing a good quality human resource for facing the globalization. This potential can be realize if science learning build up the logical thinking, creative thinking, problem solving, critical thinking, mastery the technology and adapting the globalization [1]. Reasoning skill is one of the high order thinking skill which is needed to accomplish the problems in a logical and coherent way. Reasoning skills are encompasses generating, testing and revising hypotheses or theories, reflecting on the process of knowledge acquisition and knowledge change that result from such inquiry activities [2]. Therefore, the student must have the reasoning skill to solve the problem in science learning [3] and the educators help them to find out their reasoning skill.

In fact, reasoning skill of Indonesia student is low [4]. That statement is proven by the result of the Indonesia students who followed TIMSS (Trends in International Mathematics and Science Study) in year 2015. They achieved the 45th rank from 48 country. There are three domains related to TIMSS that were testing. The three domains are knowing domain, applying domain and reasoning domain. The lowest achievement of Indonesia student is in reasoning domain.
Reasoning skill in this study referred to Lawson framework. Lawson framework identified six aspects of reasoning skill, i.e. conservation reasoning, controlling variable, proportional reasoning, probabilistic reasoning, correlational reasoning, combination reasoning [5, 6, 7]. These six aspects are the basic step to identification the reasoning skill of the student. Therefore, the instrument used in this study for measuring the reasoning skill’s student is Lawson’s Classroom Test Scientific Reasoning (LCTSR) which was modified based on pressure concept.

The LCTSR contains of 12 pairs of multiple choice two tier question with the pressure content and the reason. Reasoning skill constitutes of cognitive development stage [8]. Piaget’s theory claim that the junior high school student cognitive development is in formal operation. The student which in formal operational is capable to think abstract, logic, making a conclusion from present facts. Based on Piaget’s theory of cognitive development, Lawson classifies reasoning skill on answering the LCTSR into three level, i.e. concrete operational, transitional, and formal operational [9].

The student who stands in concrete operational level are identified by their logic thinking to solve the problem outside of a concrete context, abstract concepts and hypothetical tasks. The characteristic of formal reasoning is the student who think abstractly, reason logically, hypothetic-deductive reasoning and make some conclusions from the information. The reasoning skill of student in transitional reasoning is the formal and concrete reasoning [10]. The aim of this study is mapping the reasoning skill of student which is classified by three levels of reasoning skill, six aspects of reasoning skill and four patterns on answering the LCTSR.

2. Method
The method of this study is qualitative descriptive method. Subjects of the research was 60 students of IX grade of junior high school. They were about 13-15 years old. This study located in Pondok Pesantren Daar El Qolam Tangerang. The data was collected through Lawson’s Classroom Test Scientific Reasoning (LCTSR) test which was modified based on pressure concept. Data was analyzed based on the frequency and percentage of test result. The instrument test contains of 12 pairs of multiple choices two-tier questions with the pressure content and the reason. Student’s answer was scored 1 if they answered both pressure content and reasoning questions correctly and scored 0 if they answered incorrectly pressure content or/and reasoning question. Based on the scoring used, the student answers can form a pattern. There are four existing patterns, they are 1.1; 1.0; 0.1 and 0.0 patterns. The distribution of questions on each aspect of reasoning skill can be seen in the Table 1.

| Table 1. The Distribution of Questions on Each Aspect |
|------------------------------------------------------|
| Aspect of reasoning skill | Questions Number |
|----------------------------|------------------|
| Conservation reasoning     | 1, 2             |
| Proportional reasoning     | 3, 4             |
| Controlling variables      | 5, 6             |
| Probabilistic reasoning    | 7, 8             |
| Correlational reasoning    | 9, 10            |
| Combinatorial reasoning    | 11, 12           |

Based on Piaget’s theory of cognitive development, Lawson classifies reasoning skill on answering the LCTSR into three level, i.e. concrete operational, transitional, and formal operational. It can be seen in the Table 2.

| Table 2. The level of reasoning skill |
|--------------------------------------|
| Score | Level    |
|-------|----------|
| 0 - 4 | Concrete |
| 5 - 8 | Transitional |
| 9 - 12| Formal   |
The table 2 shows that student’s scoring in the range of 0-4 on the LCTSR test were categorized as in concrete operational. The student result between range of 4-8 on is in transitional operational and range between 8-12 on is in formal operational.

3. Result and Discussion

3.1. The Level of Reasoning Skill
We analyze students’ answer quantitatively based on their result of LCTSR which modified on pressure concept. The result of the student is mapping based on level of reasoning skill. The level of reasoning skill classified students into three formal reasoning categories: concrete operational, transitional, and formal operational. The distribution of student reasoning skill level shown in Figure. 1.

Figure 1. The distribution of student reasoning skill level

Figure 1 shows the entire result of student reasoning skill level. The findings of the study showed that 45 % students achieved in lowest level of reasoning skill. It is mean 27 of 60 students were classified as concrete operational level. 51.7 % students achieved in the middle level of reasoning skill. It is mean 31 of 60 students were classified as transitional operational level. Other two students achieved in highest level of reasoning skill which were classified as formal operational level. This indicates that majority of the participating students exhibited transitional reasoning level. This case absolutely unsuitable with Piaget’s theory of cognitive development. Piaget’s theory of cognitive development explain that the student between age 11- upper is in formal operational stage.

3.2. The Distribution of Reasoning Skill in Every Aspect
We analyze students’ answer quantitatively based on their result of LCTSR which modified on pressure concept. The result of the student is mapping the distribution of reasoning skill in every aspect. The aspects of reasoning skill consist of six aspects, i.e. conservation reasoning, controlling variable, proportional reasoning, probabilistic reasoning, correlational reasoning and combination reasoning. The distribution of student reasoning in every aspect shown in Table 3.

Table 3. The distribution of reasoning skill in every aspect

| Aspect of reasoning skill       | Frequency | Percentage |
|--------------------------------|-----------|------------|
| Conservation reasoning         | 17        | 28%        |
| Proportional reasoning         | 16        | 26%        |
| Controlling variables          | 29        | 48%        |
| Probabilistic reasoning        | 2         | 3%         |
| Correlational reasoning        | 33        | 54%        |
| Combinatorial reasoning        | 41        | 68%        |

Table 3 shows the student distribution in every aspect of reasoning skill. It shows that 3 % of the student can answer the question properly between the pressure content and the reason of probabilistic reasoning aspect. It means that 58 of 60 students answer the question incorrectly between the pressure content and/or the reason. The student who lack of the aspect of probabilistic reasoning is lack of the theoretical
probability based on the experiment, logically consistent decisions and the decisions depends on the accuracy of the subjective estimate.

Surprisingly 68% of the student can answer the question properly between the pressure content and the reason in combinatorial reasoning aspect. It means that 41 of 60 students answer the question correctly between the pressure content and/or the reason. The student who allowed this aspect can help the students to recognize cognitive conflict and resolve it. They use deductive reasoning to help students to learn the direction of force acting on a moving object.

3.3. The Pattern of Student’s Answer
Based on the scoring used, the student answers can form into a pattern. There are four existing patterns, they are 1.1; 1.0; 0.1 and 0.0 patterns.

![Figure 2](image)

Figure 2. The distribution of student reasoning in a pattern

Figure 2 shows that 37.64% of the student answer correctly between a pressure content and reason. 12.64% of the student answer the pressure content correctly and reason incorrectly, 10% of the student answer correctly between a pressure content incorrectly and reason correctly, 39.72% of the student answer incorrectly between a pressure content and reason. The existence of students who answered the questions correctly but wrong on the reason or otherwise indirectly stated that would imply that there may be a problem in the way the question was asked.

4. Conclusion
The conclusion of this study are most of the student (51.7%) classified as transitional operational level and 39.72% of the student answer incorrectly between a pressure content and reason. That we found the reasoning skill of the student is in low condition. The writer recommends several things, i.e to teachers for mapping the reasoning skill can support the educators to prepare and implement teaching effectively. For other researchers: It would be better if the instrument of scientific reasoning test is made in another concept

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