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# Lawson Instrument: Analyzing Student's Scientific Reasoning Skill in Junior High School

Retno Cahyaningrum
Muhammadiyah 8 Junior High School Batu
retnocahyani93@gmail.com

***Abstract.*** **The ability of scientific argumentation is an ability that must be mastered by students in this century. The level of scientific argumentation of students is obtained through 24 items of Lawson instrument tests. The subjects in this study were 106 students, with age range 13-15 years old, at the first middle school level. The result indicated that average score 50% less than the highest score. In addition, there were also 2 items that have a percentage of correct answers of less than 10%. Both of these findings conclude that the scientific argumentation skills of junior high school students are low. Therefore, it is recommended to develop teaching strategies that support the development of students' scientific reasoning skills.**

***Keywords: lawson instrument, scientific reasoning skill***

## INTRODUCTION

The 21st century demands everyone to have certain skills. Education can be a way to equip students with multi skills. One important skills required is scientific reasoning skill [1],[2]. In fact, each subject requires scientific reasoning skill [3] as it involves the process of students' thinking in responding to some issues or events that are related to various fields of expertise / proficiencies [4].

Scientific reasoning includes reasoning and problem solving skills dedicated to build, test and correct hypotheses or theories. Scientific reasoning is a process in which the logic of thought is applied to the science process, seeking explanations, designing hypotheses, making predictions, solving problems, producing experiments, controlling variables, analyzing data, developing empirical laws through developing meaning [2]. Besides, scientific reasoning is a skill that must be possessed by someone responding toward the challenges in this era. Thus, students can solve some open-ended real-world problems which they will encounter in the daily life and their future careers [5]. In addition, there are advantages if students can master scientific reasoning skill. One of them is that students can identify their personal interest for their higher education [6-8] .

The importance of scientific reasoning skills make students to master their lessons thoroughly. The learning efforts that have been carried out so far are also intended to improve this skill. Therefore, it is necessary to measure students' scientific reasoning abilities. This is intended to find out how much skills they have and their correlation with students' learning attitudes. This study was designed to present data analysis of students' scientific reasoning skills in junior high school.

## METHOD

This research was conducted by giving some items in the form of Lawson's Classroom Test of Scientific Reasoning (LCTSR) to 106 respondents. LCTSR is one of instruments that focuses on accessing student's scientific reasoning skill [9, 10]. All respondents are students in junior high school (SMP) with age range between 13-15 years old. We used cluster random sampling technique to select the sample. Respondents were students in grade 7 or first level in Muhammadiyah 8 Batu Middle School.

The LCTSR instrument consists of 24 items. The questions are designed in two tiers. The first tier is a problem that requires student reasoning and the second tier is the reason of choosing the answer from the first question. The first tier is in the odd number and the second tier is an even number question.

Data collection was conducted for a week by providing paper and pencil based tests. The time limit of the test was 90 minutes. The results of the tests were analyzed by looking at the value of the description statistics and the percentage of correct answers in each item.

The first data is the overall scores achieved by students. It aims at obtaining the average value, maximum value, minimum value, standard deviation, variance, and distribution of data. The average score, the maximum score and minimum score represent the level of student reasoning skills. The standard deviation value, variance, and distribution of data represent the level of data diversity and distribution.

The second data from this study is an item which has low precentage of the correct answer. In this study, the low precentage of the item was 10% or less than 10% of the correct answer. Then, the items are analyzied by the constant comparative method to describe it.

## RESULT

The implementation of the LCTSR instrument given to first grade students at Muhammadiyah 8 Batu Middle

School is divided into 2 main data. The first data is in the form of statistical data description of students' scientific reasoning skills; whereas the second data is the percentage of correct answers from items that less than 10%. The percentage of items below 10% explained that students' scientific reason skills is still low.

**The Average Score of Scientific Reasoning Skill**

The number of respondents chosen in this study has represented 5 times the number of items tested. Therefore, the data obtained truly represents the student's scientific reasoning skills.

Quantitative data analysis is carried out with descriptive statistics that include average values, maximum values, minimum values, and variances in scientific data for student's reason skills. The analysis is done using the SPSS 16.0 application. The data is presented in Table 1.

Table 1. Description of Statistic Data of Student's Scientific Reasoning Skill

| No | Statistic | Score |
|---|---|---|
| 1 | Average Score | 23,29 |
| 2 | Maximum Score | 60,00 |
| 3 | Minimum Score | 6,00 |
| 4 | Deviation Standard | 13,81 |
| 5 | Variance | 190,82 |
| 6 | Skewness | 1,36 |

Based on Table 1, the students' achievement of the average score is 23,29. This score is far below than half of the the highest score. The average score of students' scientific reasoning skills is very low with 60,00 as the maximum score and 6,00 as the minimum score. The wide range of maximum and minimum score are supported by the high variance values, which is 190,82. This value implies that the variability of data is high or the data varies [11], [12].

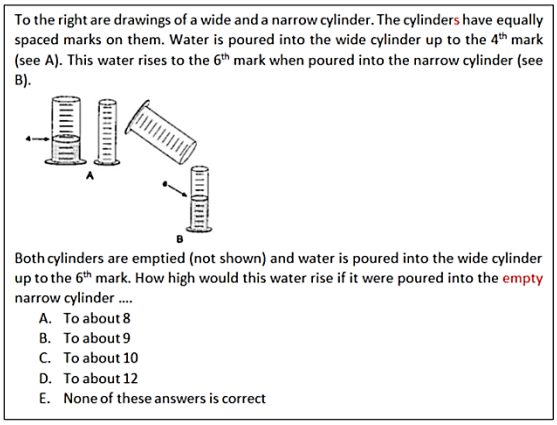
The standard deviation value is 13.81. This value shows the distribution of data, with a range of 13,81 scale. The standard deviation value will be more meaningful when the data is normally distributed. Data normality is seen from the skewness value of SPSS output, which is equal to 1.36. This value means that the data is not normally distributed because the data will be categorized as normal when the value ranges from ±1 scale [11].

Based on the description, especially the students' average score, it can be concluded that students' reasoning skills are still low. The distribution of data is also uneven as indicated by variations and standard deviations. Data distribution does not meet the normal distribution, so nonparametric statistic is used.

**Answer Percentage that Less 10%**

Based on the calculation of 24 items correct answers' precentage, it is obtained that there are two items have the precentage less than 10%. The low percentage of correct answers is found in items number 6 and 15. In this section, two items will be discussed deeper.

Item number 6 is the second tier of the main question. The LCTSR instrument used in this study has 2 tiers. The first tier is in the odd number and the second tier is in the even number. Then, the analysis should be done starting from item number 5 (Figure 1) prior to analyzing item number 6.


To the right are drawings of a wide and a narrow cylinder. The cylinders have equally spaced marks on them. Water is poured into the wide cylinder up to the 4th mark (see A). This water rises to the 6th mark when poured into the narrow cylinder (see B).



Both cylinders are emptied (not shown) and water is poured into the wide cylinder up to the 6th mark. How high would this water rise if it were poured into the empty narrow cylinder ....

A. To about 8
B. To about 9
C. To about 10
D. To about 12
E. None of these answers is correct

Figure 1. Question number 5

Question number 5 states that there are 2 different size of measuring cups but have same scale. Water is poured into large measuring cup and reaches scale 4, then the water transferred to the small measuring cup and reaches scale 6. The problem is if both cylinders are emptied again and a large cylinder filled with water until it reaches scale 6, then what scale that will seen when the water is poured back to small measuring cup.

These problems can be solved by doing mathematical calculations.

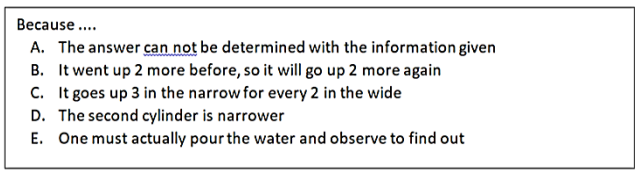
$$\frac{4}{6} = \frac{6}{x}$$

$$4 \,.\, x = 6 \,.\, 6$$

$$4x = 36$$

$$x = 9$$

Twelve students have chosen the correct answer on this item. They use the right mathematical calculations to solve the problem. However, there were not all of them chose the right reason on tier 2. The tier 2 problem, number 6, is presented in Figure 2.


Because ....

A. The answer can not be determined with the information given
B. It went up 2 more before, so it will go up 2 more again
C. It goes up 3 in the narrow for every 2 in the wide
D. The second cylinder is narrower
E. One must actually pour the water and observe to find out

Figure 2. Question number 6

The right answer is option C. But not all students who have chosen the correct answer (question number 5) will choose the correct reason (problem number 6). This finding states that students have not fully understood the purpose of the question so that even though they chose

correct answer, they were not corrected to choose the right reason.

The second question which has low precentage is item number 15 (Figure 3). This item has 5.7% from 100% of correct answers. This question used to accesses student knowledge and stimulates students to think logically.

Six square pieces of wood are put into a cloth bag and mixed about. The six pieces are identical in size and shape, however, three pieces are red and three are yellow.

R R R

Y Y Y

Suppose someone reaches into the bag (without looking) and pulls out one piece. What are the chance that piece is red ....

A. 1 chance out of 6
B. 1 chance out of 3
C. 1 chance out of 2
D. 1 chance out of 1
E. Can not be determined

Figure 3. Question number 15

The number of red block (R) and the yellow block (Y) is same, then the probability of the block being drawn is half or 1 (red block) compared to 2 (red block + yellow block). The right answer is option C. Some students stated that he knows the chance logally. However, there were not many students like them. It was explained why this question got low percentage of correct answers.

Contrast with the question number 15, more students could answer question number 16 correctly. Although the precentage still far from the 100%, but there were more students could give a correct reason. Item number 16 is presented in Figure 4.

Because ... .

A. 3 out of 6 are red
B. Three is no way to tell which piece will be picked
C. Only 1 piece of the 6 in the bag is picked
D. All 6 pieces are identical in size and shape
E. Only 1 red piece can be picked out of the 3 red pieces

Figure 4. Question number 16

In question number 16, the percentage of correct answers was 19%. It had a big gap with the precentage question number 15. This finding explains that students could not do scientific reasoning to solve the problem. But they can guess the most rational reason to choose the right answer (question number 16).

The result of two set problems (tier 1 and 2) showed that students have not been able to do scientific reasoning that focuses on the problem which required mathematical solutions. The first finding was students could answer the problem correctly but they colud not guess the correct reason. On the contrary, the second finding was students could not solve the problem with scientific reasoning but they could guess the correct reason using some logic.

One of the studies that refers to the ability of student reasoning skills is to use the Student Activity instrument based on the Drawing-based Modeling approach [13]. However, this study did not use original instruments to determine the ability of student reasoning skills, LSTR instruments. Previous researches also did not describe their findings about the thinking of students who had undergone the LTSR test [14-18]. Even though by understanding students' thinking, it can be found out the right learning so that students' scientific reasoning can be improved.

The results of student reasoning skills can also be used as a basis for learning. Graff (2018) uses the ability of scientific reasoning skills of students to design inquiry learning by comparing 4 components, namely baseline, direct learning, verbal support, and a combined approach [19]. Likewise, with the results of this study, through data obtained, the teacher can adjust the design of learning accordingly. Consideration of students' reasoning skills can help improve literacy skills and make it easier for them to master the concept.

## CONCLUSION

The instrument that used to measure students' scientific reasoning was Lawson's Test of Scientific Reasoning (LTSR) which consists of 24 items. The LTSR was given to 106 respondents who were the first-grade students in junior high school. The results showed that the average score was 23.29. The data has a high variation or 190,82. However, the data was not normally distributed because the value of skewness was 1,36. This result states that students' scientific reasoning in the first grade of Muhammadiyah 8 Batu Middle School was still low.

There were 2 set problems which has low percentage (the correct answer less than 10%). The first set is question number 5 and 6. This set showed that students could answer the reasoning problem (question number 5) correctly but they could not explain precisely the correct reason (question number 6). Whereas, in the second set (question number 15 and 16), students could not answer the reasoning problem correctly but they could answer the reason perfectly. Thus, it can be concluded that students's scientific reasoning is still low because there are some inconsistencies on the answers and reasons.

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