The relationship between students critical thinking measured by science virtual test and students logical thinking on eighth grade secondary school

R Nurismawati¹*, Y Sanjaya² and L Rusyati¹

¹International Program on Science Education, Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia, Bandung, Indonesia
²Department of Biology Education, Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia, Bandung, Indonesia

*Corresponding author’s e-mail: riana.nurismawati95@student.upi.edu

Abstract. The aim of this study is to examine the relationship between students’ critical thinking skill and students’ logical thinking skill of Junior High School students in Tasikmalaya city. The respondent consists of 168 students from eighth grade at three public schools in Tasikmalaya City. Science Virtual Test and Test of Logical Thinking were used in this research study. Science virtual test instrument consist of 26 questions with 5 different topics. IBM SPSS 23.00 program was used for analysis of the data. By the findings; students’ critical thinking skill has significant differences in elements of generating purpose, embodying point of view, utilizing concept and making implication and consequence. By Post Hoc LSD Test, from those four elements, there are significant differences between concrete–transitional groups and transitional–concrete groups. There is positive and weak correlation between students’ critical thinking and students’ logical thinking attainment.

1. Introduction

In this digital era, there is so much information spread out easily and rapidly. Thus, one of essential skills in learning and jobs for 21st century require critical thinking skills. Critical thinking comes as paramount [1]. When everything is google-able, works automatically even hoax, teaching students to think critically is very necessary [2]. Critical thinking is included in one of higher order thinking skills. Critical thinking is the form of analyzing and evaluating thinking with a point of view to improve it. Critical thinking is reasonable reflective thinking focused on deciding what to believe or do [3].

Critical thinking as major goal of education can be assessed with several ways. There are variety of methods and instruments that available to measure or assess critical thinking skill [4]. The examples are California Critical Thinking Skills Test (CCTST) and the California Critical Thinking Disposition Inventory (CCTDI). Even we can make our own test for assessing critical thinking skill. The questions of critical thinking test must be prepared by the enhancement of technology nowadays.

In measuring critical thinking skills, the presence of ICT can support various components in education, especially on assessment system. The assessment system that has been designed well and systematic makes student performance improves [5]. Then, it is necessary for developing assessment
system which can reach our core educational goals and can improve students’ skills in order to give benefits for themselves and also its society.

The form of assessment in digital era is familiar with e-assessment, e-exam or computer-based test. The development of Computer-Based Testing or well-known as CBT is included as one of the recent “innovative” approaches to assessments that most followed by countries, because it has cheaper and speeder test delivery for country and district-wide assessment. In Indonesia recently, as an example of using Computer Based Test is National Examination. Some schools which is available to provide computer in Indonesia for implementing UNBK or Computer Based National Examination. The CBT can measure different skills or sets of knowledge in order to provide new and better information about individuals’ abilities.

Another instrument already made is Science Virtual Test (SVT) as one of computer based-test to assess students’ critical thinking skills. This media has been developed [6]. The Science Virtual Test provides some problems related to science context – exactly about living things and environment, and the questions can measure students’ critical thinking. The use of computer based test is because it is easier to provide the questions by showing pictures, videos, or animation that make students more imagine the content rather than only in paper based test.

Furthermore, in think critically, intuitive and logic are needed [7]. Both are playing on critical thinking, decision making and clinical judgment. So then, the skill that researcher would like to observe is students’ logical thinking and its correlation with students’ critical thinking. The term of logic is actually reason in formal or strict way, the word of logic is easier to be measured correct or not since it needs logical sense than reasoning sense [8]. Piaget’s cognitive development leads to the meaning of logical thinking skill. The skill is seen during preoperational and concrete operational period. Logical thinking is observing and analyzing phenomenon, response, and feedback withdraw and construct conclusions based on data input [9]. By combining ICT in doing students’ critical thinking test and students’ logical thinking skill, this research study focus on the relationship between students’ critical thinking and students’ logical thinking skill measured by Science Virtual Test.

2. Methods

2.1. Research method

The research method that was used in this research is correlational descriptive non-experiment. The factual and accurate data obtained should be described systematically as representative of characteristics of specific population based on literature and the field. For the study’s design, this research used correlational because the relationship between students’ logical thinking and students’ critical thinking, students’ science score achievement and students’ critical thinking of Junior High School students was examined.

2.2. Research Subject

The location of this research was conducted in three public schools in Tasikmalaya. The accessible population in this research was all 8th grade students at three public schools in Tasikmalaya. The samples are 8th grade students from one class in each school. Technique sampling that was used for this research is purposive sampling that include in non-random sampling. Purposive sampling is chosen because the population of this research is three junior high schools in one certain city with the same curriculum or with the same status, which is public school. The total frequencies of all respondents are 168 students.

2.3. Research Instruments

As instruments, students’ critical thinking skill uses Science Virtual Test, students’ logical thinking skill uses Test of Logical Thinking (TOLT).
2.3.1. *Science Virtual Test.*

Science Virtual Test is kind of computer based test to measure critical thinking skill that has been developed [6]. This instrument contains 26 multiple choices questions provided with some features such as video, pictures, animation and etc. SVT covers eight elements of critical thinking skill which are generates purposes, raises questions, uses information, utilizes concepts, makes inferences, makes assumptions, generates implications and embodies a point of view [10]. The theme for those test items are about living things and environmental sustainability.

2.3.2. *Test of Logical Thinking.*

Test of Logical Thinking (TOLT) is used to measure students’ formal reasoning skill that has been developed [11]. The test items consist of 10 questions. First eight numbers of TOLT was provided with multiple question and multiple reasons. Then, the last two questions were provided with short answer question that should be answered by students.

2.3.3. *Data Analysis.*

SPSS version 23 program was used to analyse the data. One Way Anova Test was conducted to examine the differences of students’ critical thinking skill based on students’ logical thinking attainment since the data was normally distributed. In order to describe clearly for significant differences, Post Hoc LSD were conducted to find the exactly result and its comparison. To find out the correlation between students’ critical thinking and students’ logical thinking, Pearson product-moment correlation was used in the data analysis.

3. *Results and Discussion*

Students’ critical thinking achievement has been collected. The scores of students’ critical thinking were categorized into three groups based on students’ logical thinking result which are concrete level, transitional level and formal level. The data shows that there are 127 students included in concrete level, 39 students as transitional level and only 2 students included in formal level. Since the formal level score target range is 4 – 10 of 10 questions. The table shows the mean of each element and its significant differences.

| No | Critical Thinking Elements | Formal Level N = 2 | Transitional Level N = 39 | Concrete Level N = 127 | p value |
|----|-----------------------------|--------------------|--------------------------|------------------------|---------|
|    |                             | Mean   | SD    | Mean   | SD    | Mean   | SD    |         |
| 1  | Purpose                     | 62.5   | 17.67 | 78.85  | 20.31 | 68.31  | 23.24 | .036*   |
| 2  | Question at issue           | 62.5   | 17.67 | 42.95  | 25.62 | 42.91  | 28.15 | .608    |
| 3  | Assumption -                | -      | -     | 69.23  | 31.65 | 80.71  | 27.5  | .051    |
| 4  | Point of View               | -      | -     | 57.27  | 20.58 | 40.67  | 24.83 | .002*   |
| 5  | Information -               | -      | -     | 84     | 22.57 | 75.78  | 26.71 | .109    |
| 6  | Concepts                    | 83.35  | 23.55 | 82.06  | 26.32 | 63.26  | 29.36 | .002*   |
| 7  | Interpretation and Inference | 83.35  | 23.55 | 61.55  | 26    | 62.21  | 28    | .550    |
| 8  | Implication and Consequences| 83.35  | 23.55 | 44.44  | 29.96 | 55.39  | 29.77 | .050*   |
| Overall Critical Thinking Score | 75     | 2.69  | 65.28  | 13.12 | 60.53  | 13.7  | .063    |

*) Significant at level 0.05
As seen in the Table 1, there are the means among three level groups based on logical thinking skill. The significant differences between students’ critical thinking and logical thinking only seen in four elements, which are generating purpose, embodying point of view, utilizing concept and making implication and consequence. Those are having p value less than 0.05.

To see more details, Table 2 represents about the comparison and the significance of critical thinking attainment in formal, transitional and concrete level.

| Critical Thinking Element | (I) TOLT Level Group | (J) TOLT Level Group | Mean Difference (I-J) | Sig. |
|---------------------------|----------------------|----------------------|-----------------------|------|
| 1. Purpose                | Formal               | Transitional         | -16.34615             | .319 |
|                           |                      | Concrete             | -5.80709              | .719 |
|                           | Transitional         | Formal               | 16.34615              | .319 |
|                           |                      | Concrete             | 10.53907*             | .012*|
|                           | Concrete             | Transitional         | 5.80709               | .719 |
|                           |                      | Transitional         | -10.53907*            | .012*|
| 4. Point of View          | Formal               | Transitional         | -23.96667             | .204 |
|                           |                      | Concrete             | -7.37323              | .690 |
|                           | Transitional         | Formal               | 23.96667              | .204 |
|                           |                      | Concrete             | 16.59344*             | .001*|
|                           | Concrete             | Transitional         | 7.37323               | .690 |
|                           |                      | Transitional         | -16.59344*            | .001*|
| 6. Concepts               | Formal               | Transitional         | 1.29359               | .950 |
|                           |                      | Concrete             | 20.09016              | .327 |
|                           | Transitional         | Formal               | -1.29359              | .950 |
|                           |                      | Concrete             | 18.79657*             | .000*|
|                           | Concrete             | Formal               | -20.09016             | .327 |
|                           |                      | Transitional         | -18.79657*            | .000*|
| 8. Implication and Consequences | Formal | Transitional | 38.90897              | .073 |
|                           |                      | Concrete             | 27.96339              | .189 |
|                           | Transitional         | Formal               | -38.90897             | .073 |
|                           |                      | Concrete             | -10.94559*            | .046*|
|                           | Concrete             | Transitional         | -27.96339             | .189 |

*) Significant at level 0.05

Post hoc LSD Test indicates that from four elements there are significant differences between concrete - transitional groups and transitional – concrete groups. While for formal – concrete and transitional – concrete level, there is no significant difference.

To investigate the correlation between students’ critical thinking and logical thinking, the pearson correlation test was conducted. The result shows that there is significant difference between critical thinking skill and logical thinking skill. Findings related to the relationship between students’ critical thinking and students’ logical thinking is shown on Table 3.
Table 3. The correlation of overall students’ critical thinking attainment and students’ logical thinking

|                  | Overall SVT Score | TOLT Score |
|------------------|-------------------|------------|
| Overall SVT Score| Pearson Correlation | 1          |
|                  | Sig. (2-tailed)    | .187*      |
|                  | N                  | 168        |
| TOLT Score       | Pearson Correlation | .187*      |
|                  | Sig. (2-tailed)    | .015       |
|                  | N                  | 168        |

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

The result shows that there is significant difference between critical thinking skill and logical thinking skill. However, the significance is weak since the value is 0.187 (< 0.25). The result shows that there are only two respondents from 168 respondents only reach formal level. 39 respondents for transitional level and 127 respondents for concrete level. The questions of TOLT (Test of Logical Thinking) might be difficult for the respondents.

Meanwhile, based on the cognitive development by Piaget, 12 -15 year-old-children are on the formal operational stage so that they have been able to think logically, critically, and abstract through systematic experiments [12]. However, there are several factors that author probably find during in the field. Those are because of the time limitation for doing this test. The time given is around 30 -40 minutes while it still difficult for respondents to finish all questions. Then, because of the condition of the students during conduct the test. For example, in one class the time to conduct the test was given after physical education test, and it makes students were not focus at all. The students’ rapidity to think logically, critically, and abstract is different from one to another. Hence, the result of TOLT was not that good [13].

The result of Pearson product-moment correlation shows that there is a positive correlation between critical thinking skill and logical thinking skill. However, since the value of pearson correlation is 0.187 (less than 0.25) the correlation is including as weak correlation. The critical thinking is intuitive and logic [7]. Which means thinking logically is playing on critical thinking skill. Both are including as higher order thinking skills [14]. Based on the research result from SPSS and based on literature review, critical thinking must be has a correlation with logical thinking skill. When the student who has high score in logical thinking test, then the student will have higher score in critical thinking and vice versa.

4. Conclusion
Students’ critical thinking skill has significant differences in elements of generating purpose, embodying point of view, utilizing concept and making implication and consequence. By Post Hoc LSD Test, from those four elements, there are significant differences between concrete - transitional groups and transitional – concrete groups. There is positive and weak correlation between students’ critical thinking and students’ logical thinking attainment.

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