Profile of Students’ Critical Thinking Skill Measured by Science Virtual Test on Living Things and Environmental Sustainability Theme

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Abstract. The aims of this study are: (1) to investigate the level of students’ critical thinking skill on living things and environmental sustainability theme for each Inch’ critical thinking elements and overall, (2) to investigate the level of students’ critical thinking skill on living things characteristic, biodiversity, energy resources, ecosystem, environmental pollution, and global warming topics. The research was conducted due to the important of critical thinking measurement to get the current skill description as the basic consideration for further critical thinking skill improvement in lower secondary science. The research method used was descriptive. 331 seventh grade students taken from five lower secondary schools in Cirebon were tested to get the critical thinking skill data by using Science Virtual Test as the instrument. Generally, the mean scores on eight Inch’ critical thinking elements and overall score from descriptive statistic reveals a moderate attainments level. Students’ critical thinking skill on biodiversity, energy resources, ecosystem, environmental pollution, and global warming topics are in moderate level. While students’ critical thinking skill on living things characteristic is identified as high level. Students’ experience in thinking critically during science learning process and the characteristic of the topic are emerged as the reason behind the students’ critical thinking skill level on certain science topic.

1. Introduction
In this era, students are challenged with heaps of very much increasing information in everyday life, and coincidently human experiences and knowledge which are enormously flourishing. Considering diverse resources of information, selecting suitable materials amongst abundant sources is a difficult task for the student. Those challenges require high levels of intellectual and rational skills such as reflection, argument, understanding and evaluation, all of which are essential components of critical thinking [1]. Being focus on critical thinking, Paul also believed that acquisition of critical thinking skills is considered vital for students to face a multitude of challenges of adult life and function effectively in today’s increasingly complex world [2]. Therefore, it is necessary for critical thinking to be formed in individuals.

In corresponds of the importance of critical thinking skill, researchers and educators have been working to increase demand of critical thinker by designing instructional program that focus on the acquisition and transfer of critical thinking skills [3]. Many studies have been done in order to find out...
the way and testing the effectiveness of their findings to be implemented on the lower up to higher education program.

From one side, we can realize that the development of critical thinking skills is often listed as the most important reason for formal education because the ability to think critically is essential for success in the contemporary world where the rate at which new knowledge is created is rapidly accelerating. But however, it also important to realize that development of critical thinking is not only focus on how it is developed and implemented during the learning process. It must also be supported by a testing process. As according to Jacob and Chase, critical thinking must be supported by evaluations or tests that reflect critical thinking, because the evaluation or testing is an integral part of learning [4]. In another supported side, it also known that the developments of learning and teaching process cannot be separated and highly depend on teacher and students’ measured critical thinking skills [5]. In this sense, great responsibilities fall to the researcher in order to measure or evaluate students’ critical thinking as the object for those developments.

Based on the importance of measuring critical thinking skill asserted on the theories above, this present study provides “Profiling” as the main focus. In academic perspectives, applying profiles is the process of identifying and representing a specific subject or to identify a subject as a member of a specific group or category and taking some form of decision based on this identification and representation [6]. Hence, profiling secondary students’ critical thinking skill is expected to be a best way in figuring out the current condition of student’s critical thinking skill in science. With current description and specific respondents, the stakeholders or educators in Indonesia can take an actual and on target actions for having a solution or generating critical thinking developments.

In specific, the critical thinking used in this study is adopted from Inch et al which stated that critical thinking embodies interconnected functions of generates purpose, raises question at issue, makes assumption, embodies a point of view, uses information, utilizes concepts, makes interpretation and inference, and generates implication and consequences [7]. At the end, by using Science Virtual Test as the critical thinking measurement, this study aims to find out the level of students’ critical thinking skill on living things and environmental sustainability theme for each elements and overall; and to know the level of students’ critical thinking skill on living things characteristic, biodiversity, energy resources, ecosystem, environmental pollution, and global warming topics.

2. Experimental method

This present study use descriptive research method, or non-experimental study. This method allows the author to collect and describe the data systematically, factual, and accurate about the characteristic of specific population from literature and in the field [8]. The respondents were 331 students enrolled in seven grade of lower secondary, taken from 5 public schools in Cirebon west Java. The sampling technique used was cluster sampling that allows the researcher to generate a more efficient probability sample which spread over a great distance [9]. Thus, the sample was taken either from city or regency area with the same percentage of respondents.

The instrument was Science Virtual Test by Firman and Rusyati, which has high reliability (Cronbanch’s Alpha 0.651) and moderate difficulty level [10]. It contains 28 multiple choice test items that comprised eight elements of critical thinking skill: generates purpose, raises question at issue, makes assumption, embodies point of view, uses information, utilizes concept, makes interpretation and inferences, and generates implication and consequences [7]. In addition, those items was also made based on living things and environmental sustainability theme on VII grade science, encompassed living things characteristic, biodiversity, energy resources, ecosystem, environmental pollution, and global warming topic.

In order to determine the level of critical thinking skill, descriptive statistic data (Mean, Standard deviation, and score range) was analyzed and being categorized. The mean and the standard deviation of the data was used to categorize the students’ attainments into low, moderate and high level [11]. Hence, the critical thinking attainments on this present study is categorized on these following score range; low (Score < 43.74), moderate (43.74≤ score < 74.59), and high (score≥74.59).
3. Results and discussion

3.1. Profile of students’ critical thinking skill on eight critical thinking elements

The first objective of this study is to investigate the student’s critical thinking skill level on overall and each element. The students’ critical thinking attainments are summarized on Table 1.

Table 1. Students’ attainments in eight critical thinking elements and overall critical thinking score.

| Critical Thinking Elements          | Mean   | SD     | Minimum Score | Maximum Score |
|------------------------------------|--------|--------|----------------|---------------|
| 1. Purpose                         | 60.763 | 18.8897| 0.0            | 100.0         |
| 2. Question at Issue               | 55.438 | 24.7846| 0.0            | 100.0         |
| 3. Assumption                      | 67.372 | 33.6025| 0.0            | 100.0         |
| 4. Point of View                   | 54.381 | 29.1884| 0.0            | 100.0         |
| 5. Information                     | 54.783 | 32.3040| 0.0            | 100.0         |
| 6. Concepts                        | 59.517 | 30.0264| 0.0            | 100.0         |
| 7. Interpretation and Inference    | 61.631 | 38.0478| 0.0            | 100.0         |
| 8. Implication and Consequences    | 59.315 | 28.8325| 0.0            | 100.0         |
| Overall Critical Thinking Score    | 59.169 | 15.4254| 14.1           | 95.3          |

Table 1 shows that the students’ critical thinking skill in generating purpose, raising question at issue, making assumption, embodying point of view, using information, utilizing concepts, making interpretation and inference, and generating implication and consequences are identified at moderate level. In another side, the overall critical thinking skill of the students on living things and environmental sustainability theme is also at moderate level (59.169 on 100 scale). Compared to the mean score on other critical thinking elements, making assumption appears as the highest score attained by the students. Meanwhile, the lowest score attained by the students is lied on embodying point of view.

In associated with the frequency distribution along defined range of score, the author also represents the percentage of the students’ attainments frequency within low, moderate, and high attainments category as presented on the Figure 1. It shows a clear difference in the total student’s attainments frequency percentage on three different attainment categories. In the overall critical thinking skill, the highest percentage is lied on moderate category level. It implies that most of the...
respondents (68.88% from 331) attained $43.74 \leq \text{score} < 74.59$ range in overall critical thinking skill. In line with it, most of the respondents also achieve moderate attainments category in generating purpose, raising question at issues, utilizing the concepts, and generating implication and consequences.

In the other hand, a high frequency on low attainments category is identified on embodying point of view. In another words, most of the students achieved score $< 43.74$ on the element. In contrast, a high frequency on high attainment category is lied on using information and making interpretation and inference ability. It means that most of the student achieved score $\geq 74.59$ on those elements. It can be said that most of the respondents achieved score $\geq 74.59$ on those elements.

As middle school students, the respondents are expected at least for being “practicing thinkers” [12]. As practicing thinkers students are expected for having enough skill in thinking to critique their own plan for systematic practice, and constructing a realistic critique of their powers of thought. Results of this study presents that students’ critical thinking skill on living things and environmental sustainability theme is on moderate category, for the overall score fell above the 43.74 and below 74.59 as the cut off points. A moderate critical thinking category is characterized by mixed level analysis (beginning skill) for becoming knowledgeable of what it would take to systematically monitor the role in student’s thinking about concepts, assumptions, inferences, implications, points of view, information, and etc.

Critical thinking is defined by eight elements that make it up. Whenever people think, we think for a certain purpose within a point of view based on assumptions leading to implication and consequences. People use concepts, ideas and theories to interpret data, facts, and experiences in order for answering questions, solving problems, and resolving issues [13]. The theory lead us to realize that a moderate level of students’ critical thinking skill in this study is not a coincident thing. Ideally, a moderate overall critical thinking skill in science is also supported by at least at moderate level ability of the constructing eight thinking elements; generates purpose, raises question, uses information, utilizes concepts, makes inferences, makes assumption, generates implication, and embodies a point of view.

In line with the theory above, further exploration on every critical thinking elements attainment on science in this study revealed that the secondary students have moderate attainments in all critical thinking elements. It implies the suitability among the overall critical thinking skill as the result and the attainments on each element of thought ability as the foundation. This condition described 68.88% of the respondents of this study. At the end, it can be realized that the thinking elements are being structured in students mind during thinking process. Each of these structures has implications for the others [13]. Therefore, while the student’s ability on those elements are being trained or fostered, it is expected that overall critical thinking skill of the students also can be improved, especially in science.

We noticed that such practice resulted in significant improvement in measures that are closely related to the original task (domain-specific CT measures) [14]. Therefore, science education program should include a specific of implicit redesigned way from the existed one to improve critical thinking skill. A suggestion that might be theoretically reasonable is by inuring the students’ to be trained and evaluated for their critical thinking ability through digital technology media, as have been used on this present study; Science Virtual Test. It can be strongly considered since bringing critical thinking and digital technologies may be beneficial in providing an additional opportunity for interested students to achieve higher level of knowing and/or to practice the process of critical thinking skill [15].

3.2. Profile of students’ critical thinking skill on science topics
The second objectives of this study is to investigate the level of students’ critical thinking skill on the topics embodied on living things and environmental sustainability theme. Figure 2 represents visualization of the student’s critical thinking attainments on each topic.
Based on Figure 2 above, student’s critical thinking skill on biodiversity, energy resources, ecosystem, environmental pollution, and global warming topic are at moderate level, or mixed level analysis (beginning skills). The lowest attainment is identified on environmental pollution topic. In contrast, student achieves highest critical thinking on living things characteristic topic, which also identified at high level, or commendable analysis level (skilled).

In this study, the result revealed that the student’s critical thinking skill on biodiversity, energy resources, ecosystem, environmental pollution, and global warming topics are in moderate level. This result presents that science learning process on those elements are fair to support the student in thinking critically. Those topics also provide great opportunity for the teacher to train the students in thinking critically, due to the related popular issues. In another side, students who have high critical thinking skills on living things characteristics This conditions might be happened due to the characteristic of the topic which is common and observable in daily life. Those characteristic might be the reason for the students for having diver experiences. From the standpoint of the development of critical thinking skills some types of students appear to benefit more from engagement in diversity experiences than do other [16].

As the description of student’s critical thinking skill on the topics, it is expected that the result above can be useful for the teacher to take it as consideration in developing learning activity. If we take the value of both student’ attainments in each critical thinking element and on the science topics, it is important for teacher to train the students in strongly building their element of thought, as the process and foundation of critical thinking in science. It began more important since there is a strongly correlation among content in all subject and thinking. As Paul and Elder said that all contents is nothing more nor less than a mode of thinking (about something), a way of figuring something out, and a way of understanding something through thought [17]. Any subject or "content area" can therefore be understood as a mode of figuring out correct or reasonable answers to a certain body of questions.

In embedding critical thinking within science subject matters, a closer look at the CT instructional approaches adopted by studies included in a systematic reviews also confirm that the majority (over 75%) of the intervention studies targeted either the immersion or infusion approach [14]. This may indicate that embedding CT instruction within specific subject matter domains rather than teaching in separate courses is being considered as a more promising route to help students become critical thinkers.

4. Conclusion
In general, secondary student’s critical thinking skill on living things and environmental sustainability theme is categorized on moderate level. it is characterized by mixed level analysis (beginning skill) for becoming knowledgeable of what it would take to systematically monitor the role in student’s thinking about concepts, assumptions, inferences, implications, points of view, information, and etc.

Students’ critical thinking skill on Biodiversity, Energy Resources, Ecosystem, Environmental Pollution, and Global Warming topics are in moderate level. While students’ critical thinking skill on living things characteristic is identified as high level. Students’ experience in thinking critically during
science learning process and the characteristic of the topic are emerged as the reason behind the students’ critical thinking skill level on certain science topic.

Based on the finding and discussion, it is expected that embodying critical thinking elements ability during the science learning process might help the students to get used in thinking critically. A suggestion that might be theoretically reasonable is by inuring the students’ to be trained and evaluated for their critical thinking ability through digital technology media, as have been used on this present study; Science Virtual Test. It can be strongly considered since bringing critical thinking and digital technologies may be beneficial in providing an additional opportunity for interested students to achieve higher level of knowing and/or to practice the process of critical thinking skill.

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