Validation of science virtual test (SVT) to assess 9th grade students’ critical thinking on living things and environmental sustainability theme

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Abstract. Critical thinking, communication, collaboration, and creativity are four skills that required for 21st century education. This descriptive research is focus on students’ critical thinking and specifically how to validate the science virtual test (SVT) to assess that skill. There are 21 students (9th grade/15 years old) in Kuningan city West Java as the participants while science teacher and expert as the validators. The science virtual test (SVT) as a research instrument has constructed in multiple choice based on eight elements and 26 sub elements critical thinking. Critical thinking which developed by Inch et al. consists of eight elements namely question at issue, purpose, information, concepts, assumptions, point of view, interpretation and inference, implication and consequences. Curriculum analysis, expert judgment, legibility test and trial test are four steps in this research. The test item criterion based on trial test are accepted, accepted but need to be revised, and rejected. The reliability of the test 0.43. It means the SVT that used is reliable to assess 9th grade students’ critical thinking.

1. Introduction

There are the partnership for 21st century skills framework for 21st century learning namely core subjects, 21st century content, learning and thinking skills, ICT literacy, life skills, and 21st century assessments. Critical thinking and problem-solving skills as one of part in learning and thinking skills area [1]. Students can compete in global society if they be proficient as the communicators, creators, critical thinkers, and collaborators. These characters facilitated by the “Four Cs” skills that is critical thinking and problem solving, communication, collaboration, creativity and innovation [2]. Furthermore, millennium learners should take responsibility for problem and give critical reflection as the feedback [3]. There are eight elements of critical thinking namely purpose; question at issue; assumptions; point of view; information; concepts; interpretation and inference; implication and consequences [4].

The integration of ICT into science education is good way to provide of opportunities for students to be expert in technology [5]. Not only benefit if apply ICT in teaching and learning but also can find challenge to improve teachers skills and how to implement in classroom practices [6][7]. ICT contribute in teaching process and evaluation process. So that, this research is sequel study to construct the test item which has good validity for assessing students’ critical thinking. Based on curriculum analysis, this research build the test item with theme “on Living Things and Environmental Sustainability Theme”. This theme was covered by core competence and basic competence in 7th grade, 8th grade and
9th grade (13-15 years old). Test item of Science Virtual Test (SVT) in 7th grade [8] and 8th grade [9] has been validated.

2. Methods
Descriptive research to be method in this research that summarize comprehensively about specific profile which experienced by individuals or group [10]. Validation result of Science Virtual Test (SVT) has been analysis and to be specific profile from group of individuals. There are 21 students (9th grade/15 years old) in Kuningan city West Java as the participants while science teacher and expert as the validators. The science virtual test (SVT) as a research instrument has constructed in multiple choice based on eight elements and 26 sub elements critical thinking. Critical thinking which developed by Inch et al. consists of eight elements namely question at issue, purpose, information, concepts, assumptions, point of view, interpretation and inference, implication and consequences. Curriculum analysis, expert judgment, legibility test and trial test are four steps in this research.

3. Result and Discussion
Description of curriculum analysis, expert judgment, legibility test and trial test are results in this research. Further discussion for each profile explained in follow subsection.

3.1 Curriculum Analysis based on Curriculum 2013 Indonesia on theme "Living Things and Environmental Sustainability" in 9th grade Junior High School.
The content of Science Virtual Test (SVT) be made by theme “Living Things and Environmental Sustainability”. This theme was supported by core competence and basic competence in Junior High School based on Curriculum 2013 Indonesia. The topic for 9th grade are electricity, magnetism, and biotechnology. These topics comes from analysis that represented in Table 1.

Table 1. Analysis of core competence and basic competence on the theme of "Living Things and Environmental Sustainability" in 9th grade Junior High School

| Core Competence | Basic Competence | Topic |
|-----------------|-----------------|-------|
| 2. Respect and appreciate honest behavior, discipline, responsibility, caring (tolerance, mutual cooperation), courtesy, confidence, in interacting effectively with the social and natural environment within the range of relationships and whereabouts. | 2.3 Demonstrate frugal behavior in daily activities as a manifestation of austerity in using electrical energy. | Electrical energy |
| 3. Understanding and applying knowledge (factual, conceptual, and procedural) based on the curiosity about science, technology, art, culture related to phenomena and events that appear to the eye. | 3.5 Describe the characteristics of electrical circuits, transmission of electrical energy, alternative electrical energy sources (including bioenergy), various efforts to save electricity, as well as electrical technology used in electrocardiography (EKG) and hearing aids. | a. Electrical circuits b. Transmission of electrical energy c. Alternative electrical energy sources |
| 4. Processing, presenting, and reasoning in the concrete realm (using, parsing, stringing, modifying, and making) and abstract domains (writing, reading, counting, drawing, and making) in accordance with what is learned in school and other sources that are the same in point of view / theory | 4.7 Present data and reports on the application of biotechnology in supporting human survival through food production | Biotechnology |
| | 4.8 Presenting data and information about technological processes and products that do not damage the environment | Technological processes |
3.2 Analysis based on Expert Judgement for Science Virtual Test (SVT) on theme "Living Things and Environmental Sustainability" in 9th grade Junior High School

There are five aspects for judgment process from experts (lecturers) namely (a) the test items used are in accordance with the sub-elements of critical thinking (b) the answer criteria are in accordance with the questions made (c) information or articles presented are useful for students in answering questions (d) the language used has used good and correct Indonesian (e) the criteria for distractors are according to the standards for making multiple choice questions. Recommendations from expert for Science Virtual Test (SVT) specifically (1) the video is replaced with a more representative one, because the video does not display information about the behavior of the surrounding community (2) there is a typing error (3) distractor of part A is corrected with a more logical one (4) the sentence question is too complicated for middle school students (5) the moving image will be more representative to display the issue/information on the characteristics of living things (6) option B and C seem ambiguous (7) there are two correct answers, A and B based on the video (8) in terms of language, you should use a significant and realistic word simplified with a language that is easier for students to understand (9) the meaning of the word "target" when viewed from the deception feels ambiguous (10) information on the video has not been able to convey data needed by students in answering questions.

3.3 Analysis based on Legibility Test for Science Virtual Test (SVT) on theme "Living Things and Environmental Sustainability" in 9th grade Junior High School

There are five aspects for legibility test from science teachers namely (a) information on articles/pictures/comics/tables is easily understood clearly (b) questions are easily understood clearly (c) questions are easily understood clearly (d) questions and answers are interrelated (e) there are no words/terms that are difficult to understand or cause ambiguous meanings. Recommendations from science teachers for Science Virtual Test (SVT) specifically (1) some images are less helpful in answering questions (2) the information on the video should be cut in certain parts that support the problem (3) the word "assumption" will be heard strange by middle school students (4) if you have used graphics, try to minimize the information text (5) test narration is shortened to make it more interesting to read (6) information as a stimulus to answer questions needs to be supplemented with statements that support answers (7) the deceit was replaced with a statement that was equally opposed but lacking in connection with the video (8) the video seems ambiguous without narration (9) you should have a dubbing translator that explains the phenomena in the video or is replaced with an Indonesian language video (10) questions are better changed with languages that are easier for children to understand.

3.4 Analysis based on Trial Test for Science Virtual Test (SVT) on theme "Living Things and Environmental Sustainability" in 9th grade Junior High School

Participants in this step are students in 9th grade (15 years old). They answer the test items that has been developed in Science Virtual Test (SVT). Their answer has been analysis by statistical test and some results show in Table 2.

Table 2. Analysis based on Trial Test for Science Virtual Test (SVT)

| Test Item | Result of Statistical Test | Decision |
|-----------|---------------------------|----------|
| Distinction (%): 33.33 | Difficulty: Medium | Correlation: 0.349 | Sign Correlation: Significant |
| Deception Quality: | A. bad (-) | Accepted |
| B. answer key (**) | C. bad (-) |
| D. very bad (---) | |
| Test Item | Result of Statistical Test | Decision |
|-----------|---------------------------|----------|
| Distinction (%): 16.67  
Difficulty: very difficult  
Correlation: 0.058  
Sign Correlation: -  
Deception Quality:  
A. answer key (**)  
B. Very good (++)  
C. good (+)  
D. very good (+++) | Accepted but needs to be revised.  
Video footage as information is considered too long and does not focus on the problem. |
| Distinction (%): 33.33  
Difficulty: difficult  
Correlation: -0.098  
Sign Correlation: -  
Deception Quality:  
A. not good (-)  
B. Very good (++)  
C. not good (-)  
D. answer key (**+) | Rejected |
| Distinction (%): 33.33  
Difficulty Level: easy  
Correlation: 0.518  
Sign Correlation: very significant  
Deception Quality:  
A. answer key (**)  
B. good (+)  
C. bad (-)  
D. good (+) | Accepted |
| Distinction (%): 33.33  
Difficulty: moderate  
Correlation: 0.202  
Sign Correlation: -  
Deception Quality:  
A. not good (-)  
B. answer key **  
C. very good (+++)  
D. good (+) | Accepted but needs to be revised.  
The homogeneity of the answer choices needs to be corrected, so the answer key is not too flashy |
| Distinction (%): 0.00  
Difficulty Level: easy  
Correlation: -0.008  
Sign Correlation: -  
Deception Quality:  
A. very bad (---)  
B. answer key (**)  
C. good (+)  
D. good (+) | Rejected |

The test item criterion based on trial test are accepted, accepted but need to be revised, and rejected. The reliability of the test is 0.43 (score total). It means the SVT that used is reliable to assess 9th grade students’ critical thinking. Accordingly, multiple choice can use as instrument for measuring students’ critical thinking. This result in line with another research result which describes that multiple-choice test items can use for promoting and measuring critical thinking [11]. In addition, scientific process be required for developing testing tools which have good consistent [12].
4. Conclusion
The Science Virtual Test (SVT) has constructed in multiple choice based on eight elements and 26 sub elements critical thinking. Critical thinking which developed by Inch et al. consists of eight elements namely question at issue, purpose, information, concepts, assumptions, point of view, interpretation and inference, implication and consequences. Curriculum analysis, expert judgment, legibility test and trial test are four steps in this research. The test item criterion based on trial test are accepted, accepted but need to be revised, and rejected. The reliability of the test 0.43. It means the SVT that used is reliable to assess 9th grade students’ critical thinking.

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