The validation of science virtual test to assess 7th grade students’ critical thinking on matter and heat topic (SVT-MH)

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Abstract. The method used in this research was descriptive research for profiling the validation of SVT-MH to measure students’ critical thinking on matter and heat topic in junior high school. The subject is junior high school students of 7th grade (13 years old) while science teacher and expert as the validators. The instruments that used as a tool to obtain the data are rubric expert judgment (content, media, education) and rubric of readability test. There are four steps to validate SVT-MH in 7th grade Junior High School. These steps are analysis of core competence and basic competence based on Curriculum 2013, expert judgment (content, media, education), readability test and trial test (limited and larger trial test). The instrument validation resulted 30 items that represent 8 elements and 21 sub-elements to measure students’ critical thinking based on Inch in matter and heat topic. The alpha Cronbach (α) is 0.642 which means that the instrument is sufficient to measure students’ critical thinking matter and heat topic.

1. Introduction
Critical thinking is the skill to prevent people from making bad decisions and helps to solve the problems [1]. Teaching critical thinking at schools has been the main topics in the discussion regarding 21st Century skills [2]. The higher order thinking and complex information in the critical thinking test can be supported by the advanced technology in its development. The assessment also has been shifted towards the use of computer-based procedures [3]. Researchers have the possibility to design meaningful and motivating real-life scenarios, where students can solve complex and interactive problems [4].

Computer based test is effective solution for education evaluation [5]. The major advantage of computer-based tests is in the assessment of new content areas and constructs [6]. Additionally, the use of computer based assessment is advantageous due to test economics, improvements in objectivity, and test reliability [6].

According to UNESCO (2000) measuring the improvements of critical thinking skills will essentially improve the education quality [7]. If tests are understood to shape both the curriculum and teaching, an efficient way to improve the quality of education in critical thinking is developing the better tests [8]. This better test is resulted from the validation of the test.
Recognizing the lack of specific content of critical thinking tests, it is required to validate critical thinking test in specific subject area. The present study addressed this concern in validating a critical thinking test based on Inch Critical Thinking in 7th science for junior high school student. The multiple-choice questions that indicate the elements and sub-elements of critical thinking on matter and heat topic that implements computer-based test is called as SVT-MH (Science Virtual Test Matter and Heat)

2. Methods
The method that used in this research was descriptive research for profiling the validation of science virtual test to measure students’ critical thinking on matter and heat topic. The research subject is junior high school students of 7th grade while the expert (expert of science content, expert of media, and expert of education) as the validators.

The location of this research is Public Junior High School “X” in Kabupaten Bandung. The school uses Bahasa Indonesia in teaching learning process, implements 2013 curriculum and supported by multimedia facilities e.g. personal computer. The instrument that used as a tool to obtain necessary data are rubric expert judgment (content, media, education) and rubric of readability test.

3. Result and Discussion
Result of this research is the instrument of science virtual test in matter and heat topic which is further called SVT-MH that consist of 30 items which represents 8 element and 21 sub element of Inch critical thinking. It is described based on its steps validation which are the analysis of core competence and basic competence, expert judgment (expert of science content, expert of media, and expert of education), readability test and limited trial test results of science virtual test on the topic “matter and heat” in 7th grade Junior High School.

3.1. Analysis of Core Competence and Basic Competence on the topic of "Matter and Heat" in 7th grade Junior High School
The topic chosen in this study is "Matter and Heat". This topic is abstract for Junior High School students, so the material is better to be presented virtually. The first stage done before designing the blueprint for science virtual test is to analyse the science curriculum (core competence and basic competence) in Junior High School that represent with the topic of the research. Analysis has been done on the science syllabus of 7th grade for the production of science virtual test. The topic is covering the sub topic of matter (element, compound, mixture), physical and chemical properties, physical and chemical change, state of matter and its change, temperature, expansion, heat and heat transfer.

Recapitulation of the analysis of core competence and basic competence on the topic of “Matter and Heat” in 7th grade junior high school is presented in Table 1.

| Core Competence | Basic Competence | Sub-Topic |
|-----------------|------------------|-----------|
| 1. Memahami pengetahuan (faktual, konseptual, dan prosedural) berdasarkan rasa ingin tahu tentang ilmu pengetahua, teknologi, seni, budaya terkait fenomena dan kejadian tampak mata. | 3.2. Menjelaskan konsep campuran dan zat tunggal (unsur dan senyawa), sifat fisika dan kimia, perubahan fisika dan kinia dalam kehidupan sehari-hari. | Matter (element, compound, mixture), physical and chemical properties, physical and chemical change, state of matter and its change |
| 3.4 Menganalisis konsep suhu, pemuiaan, kalor, perpindahan kalor, dan penerapannya dalam kehidupan sehari- | | Temperature, expansion, heat and heat transfer |

Table 1. Recapitulation of the analysis of core competence and basic competence in 7th grade junior high school
3.2. Analysis The Expert Judgment of Science Virtual Test on the topic of "Matter and Heat" by Expert of Science Content

The expert judgment about the content of SVT-MH was conducted with two lecturers. This judgment has four aspects assessed in each question, namely (1) the information about "heat and matter" has been delivered clearly; (2) using the appropriate term in accordance with the rule stated in science; (3) article/figure/comic/video/table/graph was appropriate with the rule stated in science; (4) the caption/explanation about the article/figure/comic/table/graph was appropriate with the rule stated in science.

The recommendation of expert judgment about the content of SVT-MH by expert of science content namely (1) There term Matter in Junior High School Student is “Klasifikasi Zat” not “Materi”; (2) Nowadays, the fuel is not only from coal and oil but also gas (LPJ); (3) The term “tariknya” in physics usually use “gaya tarik”; (4) The explanation on the video is direct answer, so the video should be edited according to its importance; (5) There are ambiguous name of the subjects in the comic; (5) There are mistype in the word “penjernihan”, “kelembaban” and “penyeberangan”; (6) Physics usually use the term “particle” rather than “molecule”; (7) Change the word “mengalirkan” becomes “menghantarkan”; and (8) Give the explanation for X and Y axis of the graph.

3.3. Analysis The Expert Judgment of Science Virtual Test on the topic of "Matter and Heat" by Expert of Media

The expert judgment about the media of SVT-MH was conducted with two lecturers. This judgment has four aspects assessed in each question, namely (1) The text’s composition (size, colour, font) was clear so it was readable; (2) There was a concordance between text colour and background; (3) The quality of illustration (figure, video, animation) was good in term of position, size, and colour; (4) The position and navigation button consistently arranged and they had the similar colour and function in each screen.

The recommendation of expert judgment about the media of SVT-MH by expert of media namely (1) Navigation to exit after seeing the answer sheet is difficult; (2) Pay attention in giving the space in each item; (3) The numbering is confusing (there are two of the numbers); and (4) Pay attention to the quality of video.

3.4. Analysis The Expert Judgment of Science Virtual Test on the topic of "Matter and Heat" by Expert of Education

The expert judgment about science content of SVT-MH was conducted with two lecturers. This judgment has only one aspect assessed in each question, namely the item used had been appropriate with the sub-element of critical thinking. The recommendation of expert judgment about science virtual test by expert of education namely (1) Make the information (comic and video) more clearly; (2) Use one term (suhu/temperatur); (3) Don’t use figure to trigger student to develop the sub-element of critical thinking; (4) The word “not” in the stem can be bolded or underlined; and (5) Give the explanation for X and Y axis of the graph.

3.5. Analysis The Readability Test of Science Virtual Test on the topic of "Matter and Heat"

The readability test about SVT-MH was conducted with 3 students of junior high school and 2 science teachers. There are five aspects assessed in each question, namely (1) The description of the article/figure/comic/video/table/graph was easily to comprehend; (2) The question was easily to comprehend; (3) The option was easily to comprehend; (4) There was correlation between the question...
and the answer; and (5) There was no ambiguous word/term which made student find difficulties in comprehending the question.

The recommendation of readability test on multiple choice questions of SVT-MH are: (1) The word "paraffin wax" elusive; (2) Students can assume all the options are right, make the words “tujuan utama” in bold or italic; (3) For JHS students, there should be a common name for the chemical gas. Example: CO2 (Carbon dioxide); (4) There is mistyping in several words.

3.6. Analysis The Trial Test Results of Science Virtual Test on the topic of "Matter and Heat"
The test items that have been verified by the expert, then the test field of the instrument was conducted on 7th grade of students from a public Junior High Schools. The total respondent of test were 117 students. The data obtained from the test were used in the statistical analysis. The analysis of the result was using IBM SPSS Statistics Version 23 and ANATES Program Version 4.1.0. The result show the reliability, item difficulty, item discrimination, and distractor analysis.

Table 2. Result of SVT-MH Reliability

| Respondent | Alpha Cronbach |
|------------|---------------|
| 40         | 0.638         |
| 117        | 0.642         |

The result showed in the Table 2 that reliability of the test of 40 students $\alpha = 0.638$ while the test of 117 students $\alpha = 0.642$. It is common to see the journal articles where one or more scale alphas which the range is 0.60 - 0.69 [9]. It interpreted as ‘acceptable’. So, the instrument is sufficient to measure students’ critical thinking on heat and matter topic.

There are two steps of trial test which are limited trial test and larger trial test. SVT-MH package contains 30 validated multiple-choice questions are made based on the elements and sub-elements of critical thinking. The item difficulty, item discrimination, and distractor analysis of each item have been measured by the ANATES version 4.1.0 analysis. The examples of the item card and its analysis that represents different information of the item (video, article, comic, figure, graph) can be seen in Figure 1.
Figure 1.a shows that difficulty level of the item no.5 is categorized in ‘moderate’ level (0.58). The discriminating power is categorized into ‘good’ discriminating power (0.44). The item no.5 can differentiate the high and low achiever of the students. The distractor A is chosen by 12.8% students, B is chosen by 6.9% students and D is chosen by 22.2% students. It means that all distractor are usable.

Figure 1.b shows that difficulty level of the item no 14 is categorized in ‘moderate’ level (0.42). The discriminating power is categorized into ‘good’ discriminating power (0.50). The item no.14 can differentiate the high and low achiever of the students. The distractor B is chosen by 10.3% students, C is chosen by 20.5% students and D is chosen by 27.4% students. It means that all distractor are usable.

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SVT-MH has been validated using the average congruency percentage resulted the 30 items which represents 8 elements and 21 element of Inch critical thinking. The item is valid if the percentage is 90% or higher [10]. This instrument has several features: (1) The instrument to measure students’ critical thinking skill which is validated in specific subject topic. The topic is based on the two basic competence of Curriculum 2013 that integrates each other. The connected topic is matter and heat. The content of an introductory Electricity and Magnetism course and resulted the design of CTEM (Critical Thinking Electricity and Magnetism) test [11]. (2) The items that has been validated is in the form of the multiple choice. Multiple choice items is more objective rather than essay to analysis the
profile of students because every single item of critical thinking sub-element has the exact answer. Multiple choice items are quick and easy to score by hand or electronically, can be written so that they test a wide range of higher-order thinking skills, can cover lots of content areas on a single exam and still be answered in a class period [12]. (3) SVT-MH uses the computer based test which follow the advanced of technology because the utilization of technology in educational assessment is aimed at the effectiveness and efficiency of the implementation of the test [13] [14].

4 Conclusion
Validation of SVT-MH, the instrument to measure students’ critical thinking on the topic of "Matter and Heat" in 7th grade Junior High School shows that the developed test are all accepted, but need revision. The reliability of the test is also acceptable. It means the test instrument is sufficient to measure students’ critical thinking.

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