Comparing Science Virtual and Paper-Based Test to Measure Students’ Critical Thinking based on VAK Learning Style Model

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Abstract. This research was comparing virtual and paper-based test to measure students’ critical thinking based on VAK (Visual-Auditory-Kynesthetic) learning style model. Quasi experiment method with one group post-test only design is applied in this research in order to analyze the data. There was 40 eight grade students at one of public junior high school in Bandung becoming the sample in this research. The quantitative data was obtained through 26 questions about living thing and environment sustainability which is constructed based on the eight elements of critical thinking and be provided in the form of virtual and paper-based test. Based on analysis of the result, it is shown that within visual, auditory, and kinesthetic were not significantly difference in virtual and paper-based test. Besides, all result was supported by quistionnaire about students’ respond on virtual test which shows 3.47 in the scale of 4. Means that student showed positive respond in all aspet measured, which are interest, impression, and expectation.

1. Introduction
Nowadays, educational world has been try to emphasize on digital multimedia known as Technology-based assessment (TBA). Soon TBA will replace paper-based testing, extend business and substance of assessment in education[1]. Parallel to these tendencies, paper-based assessment reached its limits[2]. Further development such as reduction of costs, logistic and feedback time is unexecutable with paper-based test tools[3]. Supporting the information about computer based test, the creation of a technology-enriched classroom appears to have a positive effect on student acquisition of higher-order thinking skills[4]. Critical thinking as one of higher order thinking skill can be simply put in contrast to illogical or irrational ways of thinking[5]. However, it cannot be equated with argumentative types of thinking or making criticisms[6]. Critical thinking further involves reflective types of thinking, that is thinking about activities[7]. Refers to that, critical thinking was necessary to be brought as a skill that possible to be measured in implementation of computer based test. Other thing which also interesting to discuss is a finding which stated that male and female students have significantly different learning styles. It was the responsibility of the instructor to address the diversity of learning styles and develop appropriate learning approaches⁸.
2. Research method
The method used in this research was experiment method which is pre-experiment methods specified into one group postest only design. Firstly, the data about students’ learning style was obtained through VAK (Visual-Auditory-Kynesthetic) learning style inventory by Victoria Chislett. The learning style inventory was a set of multiple choice questions with three options where each option indicated one kind of learning style. Further, one group of student was given set of question in form of paper-based test. In the next following weeks, the students were given set of questions provided in science virtual test. This method was appropriate with the objective of the research which is comparing vitual test and paper-based test to measure student critical thinking on living thing and environmental sustainability.

3. Result and discussion

3.1. Comparison between science virtual test and paper-based test
The data about general comparison between science virtual test and paper-based test is obtained by implementing those two tests on the population. As it is analyzed using statistical analysis, both science virtual test and paper-based test are shown that the data is not homogen as well it doesn’t distribute normally. It can be indicated from Asymp. Sig which is less than 0.05. Refers to that, there should be nonparametric statistical analysis used. This research is using Mann-Whitney (U) in order to analyze the data.

| Element of Critical Thinking | Science virtual Test | Paper-based Test | Mean diff. | U | Asymp. Sig |
|------------------------------|----------------------|------------------|------------|---|------------|
| Element 1                    | 82.05                | 60.00            | 22.05      | 412.0 | 0.000*     |
| Element 2                    | 49.36                | 45.00            | 4.36       | 743.0 | 0.563      |
| Element 3                    | 82.05                | 28.75            | 53.30      | 2085  | 0.000*     |
| Element 4                    | 54.70                | 47.50            | 7.20       | 751.0 | 0.606      |
| Element 5                    | 87.82                | 63.75            | 24.07      | 385.0 | 0.000*     |
| Element 6                    | 73.68                | 55.83            | 17.85      | 512.0 | 0.003*     |
| Element 7                    | 76.92                | 49.16            | 27.76      | 403.5 | 0.000*     |
| Element 8                    | 78.63                | 46.63            | 32.00      | 409.0 | 0.000*     |
| Average                      | 73.15                | 49.58            | 23.57      | 6.000 | 0.006*     |

* significant differences
Green mark : most different
Orange mark : less different

From Table 1, it can be inferred that the mean difference between science virtual test and paper-based test is all show positive value. Means that, science virtual test has higher result compare to paper based test. Specifically, the most different is showed in element three which is about “assumption”. While the less difference is showed in element five which is about “information”. From eight elements of critical thinking, there are six elements which shows that science virtual test is significantly different compare to paper-based test where it is signed by Asymp Sig, which is less than 0.05. Meanwhile, the other two elements showed that there is no significant difference in science virtual test compare to paper-based test where it is signed by Asymp. Sig which is greater than 0.05.
One potential limitation for realizing the benefits of computer-based assessment in both instructional assessment and large scale testing comes in designing questions and tasks with which computers can effectively interface. It was also parallel with the implementation of computer based test in Indonesia. Science virtual test is available to be implemented in order to improve the technology based assessment. It is available to make the assessment process becoming more effective as it was paperless, costless, and drive the student to enjoy the test more compare to conventional testing known as paper and pencil test. Besides, the creation of a technology-enriched classroom appears to have a positive effect on student acquisition of higher-order thinking skills[4]. As one of higher order thinking skill, students’ critical thinking which is measured in this research by using science virtual test is significantly higher than what is resulted on paper-based test.

On the other hand, the implementation of science virtual test is dependently require such kind of supported technology included laptop, personal computer, LCD Projector, and suitable audio speaker or earphone. The absence of technology absolutely influence the implementation of science virtual test especially in most of Indonesian public school. But anyway, the clarity of test item is still fulfilled by the direct visualization of certain concept regarding living thing and environmental sustainability.

Never the last, there are two elements of critical thinking which showed that there is no significant difference between science virtual and paper-based test. Those are about “question at issue and concept” critical thinking elements. Refers to the result, students’ skill regarding questioning was not dependent on technology. In addition, King on the study about effects of self-questioning training on college students' comprehension of lectures stated that teacher should also engage the students to provide a learning environment which enable the student to raise their questioning skill thus their critical thinking especially question at issue element will be improved[10].

The result also showed that there is no significant difference between science virtual test and paper-based test regarding the element of concept. Concept has strong relation to cognitive perspective. Cognitive perspectives drives the students to set certain concept which is required to be understood and criticized through questionning the exists concept. In addition, student willingness to gain their concept knowledge has also expected to be increased as the pre requisite on criticize certain concept[6]. Parallel to that, the psychologist Albert Bandura discovered the importance of behavioral models when he was working with patients with snake phobias. Observational learning could not occur unless cognitive processes were at work[11]. Therefore, improvement of observational experience is required in order to increases students’ critical thinking especially in the element of concept.

Other than that, education must be started to act on a new strategies as 21st century educational demand, one of them is through innovation on leaning. It drives the student to improve their learning behavior. Learning behavior proceed could change the assumption, belief, and habit[12].

3.2. Comparison between science virtual and paper-based test based on vak lenrning style
The data about the effect of learning style in science virtual test and paper-based test is analyzed by mean of investigating the difference within visual, auditory, and kinesthetics in each element. The statistical analysis in this part has been conducted through anova since the variable which is compared are more than two. Besides, the result obtained for the whole element is also investigated in order to know whether there is a difference within visual, auditory, and kinesthetics for the total element as can be seen in Table 2. The same analysis is also implemented for paper-based test in order to find out the comparison between both test.
| Test                          | Element of critical thinking | Visual     | Auditory    | Kinesthetic | F     | Asymp. Sig |
|------------------------------|-----------------------------|------------|-------------|-------------|-------|------------|
|                              |                             | Mean       | SD          | Mean        | SD    |            |            |
| Science Virtual Test         | Element 1                   | 80.88      | 18.81       | 90.62       | 12.93 | 83.78      | 20.12      |
|                              | Element 2                   | 48.53      | 20.67       | 59.38       | 22.90 | 60.95      | 16.48      |
|                              | Element 3                   | 85.29      | 23.48       | 93.75       | 17.68 | 75.33      | 31.99      |
|                              | Element 4                   | 60.79      | 21.20       | 45.83       | 17.25 | 51.11      | 24.77      |
|                              | Element 5                   | 86.75      | 19.99       | 90.63       | 12.93 | 84.75      | 15.25      |
|                              | Element 6                   | 70.59      | 26.04       | 63.33       | 31.27 | 58.88      | 24.77      |
|                              | Element 7                   | 78.43      | 26.19       | 87.50       | 17.25 | 71.11      | 33.02      |
|                              | Element 8                   | 82.35      | 23.91       | 75.00       | 29.55 | 67.88      | 33.02      |
|                              | Average                     | 74.20      | 22.54       | 75.75       | 20.22 | 70.00      | 25.49      |
| Paper-Based Test             | Element 1                   | 55.82      | 26.43       | 59.38       | 22.90 | 61.67      | 28.14      |
|                              | Element 2                   | 39.71      | 23.48       | 37.50       | 23.14 | 29.55      | 25.49      |
|                              | Element 3                   | 32.35      | 35.09       | 25.00       | 37.29 | 26.67      | 25.82      |
|                              | Element 4                   | 50.98      | 35.59       | 45.88       | 35.36 | 44.45      | 29.59      |
|                              | Element 5                   | 67.65      | 26.70       | 59.38       | 22.90 | 61.67      | 29.68      |
|                              | Element 6                   | 64.70      | 21.96       | 45.83       | 30.54 | 51.11      | 21.33      |
|                              | Element 7                   | 49.02      | 35.59       | 49.99       | 25.19 | 48.88      | 27.79      |
|                              | Element 8                   | 45.09      | 40.78       | 54.16       | 24.80 | 44.44      | 29.99      |
|                              | Average                     | 50.66      | 30.70       | 47.14       | 27.77 | 49.24      | 27.21      |
|                              | **Average**                 | 50.665     | 30.70       | 47.14       | 27.77 | 49.24      | 27.21      |

* significant differences
Green mark : most different
Orange mark : less different

From Table 2, it can be inferred that within visual, auditory, and kinesthetic there is no element which showed that those three group has significant difference in each element as well as what are showed in the result showe in each element on paper-based test. The same as in the total comparison where it is showed that there is no significant difference within visual, auditory, and kinesthetic group. Specifically, the most different showed in science virtual test is in element three which is about “assumption”, while the less difference is showed in element five which is about “information”. Hence, the most different showed in paper-based test is in the element one which is about “purpose”, while the less difference is showed in element six which is about “concept”.

Learning style is a component of the wider concept of personality. McAdams and Pals (2006) offer a five-principle model of the whole person that encompasses evolutionary design for human nature, dispositional traits, characteristic adaptations, self-defining life narratives, and socio-culture contexts[13]. Learning style falls into the categories of dispositional traits and characteristic adaptations where there are differences across individual humans but there are groupings of humans who have common or similar learning style[14]. Other than that, Gender, competitiveness, and the familiarity were not related to the
students’ performance in both science virtual test and paper-based test[15]. Science virtual test could still implemented for all students regardless those factors. Specifically, the research showed that there is no difference between students’ critical thinking between science virtual test and paper-based test measured based on VAK Learning style. Means that science virtual test can be implemented for student with any kind of learning style. It might be because science virtual test provides such kind of media which was available for visual, auditory and kinesthetic group[16]. It was in line with research done by Myers and Dyer in the research entitled “The Influence of Students’ Learning Style on Critical Thinking Skill” showed that Males and females in this study possess similar levels of critical thinking skills[16].

4. Conclusion
The research about comparing science virtual test and paper-based test to measure students’ critical thinking based on living thing and environmental sustainability has been conducted systematically based on the result and discussion. Science virtual test shows higher score compare to paper-based test score in most elements of critical thinking, there are only two elements shows insignificant result of comparison. Hence, the total comparison shows that science virtual test is significantly difference which is higher than paper-based test. Besides, comparison between science virtual test and paper-based test do not influenced by the effect of learning style, and students’ experience. It is available to be implemented in all students regardless the classification of those three aspect.

5. References
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