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To cite this article: E Istiyono *et al* 2020 *J. Phys.: Conf. Ser.* **1440** 012062

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Development of computer-based test in critical thinking skill assessment of physics

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Abstract. The development of Science and Technology in the 21st century progress in various aspects of life. Critical thinking skills are kind of the skills that must be possessed by students as a graduate competency standard. However, this skill is rarely assessed, as there are not many technological instruments to measure the skill. This research was conducted to develop critical thinking skills test instruments in the form of computer-based test (PhysTeCTS-CBT) with Define, Design, Development, and Dissemination (4D) as the method involving three experts. The feasibility of PhysTeCTS-CBT assessed by expert judgment in media feasibility categories. The results of the media validation by three experts indicate that the PhysTeCTS-CBT can be stated valid and has good categories.

Keywords: *critical thinking skills, physics assessment, computer-based test, PhysTeCTS-CBT*

1. Introduction

The development of science and technology in various aspects of life have an impact on the demands of competency. Therefore, reforms need to be done in implementing learning education in the era of the 21st century. 21st century learning has been discussed for the challenges in the industry revolution 4.0. The term of the 21st century skills generally refer to core competency collaboration, digital literacy, critical thinking, and problem solving in the face of the globalized world [1]. 21st Century Skills also believe that graduates should have the skills learned in the information, communication, critical thinking and problem solving [2]. Therefore, it is important to teach higher-level thinking skills, especially solving problems in real-world problems [3].

The curriculum is a set of plans that are used as guidelines in organizing learning activities to achieve national education goals. Indonesia, since 2013, began using the new curriculum, the curriculum of 2013. Basic inauguration of this curriculum is to better understand the competencies achieved in the learning process and the importance of training students to think at a high level, so that students are accustomed to think on a higher level and be able to compete on a competitive basis. In the learning process, so that the learning process effectively and efficiently carried out, the teacher must make a judgment. Rate is defined as the procedures used to obtain information to measure the level of knowledge and skills of students for evaluation [4].

There are six aspects that can be used to determine critical thinking skills, namely explanation, interpretation, inference, analysis, evaluation, and self-regulation [5],[6]. Interpretation includes categorizing, code breaking, and clarifying the meaning. Analysis includes testing ideas or ideas, detecting arguments, and analyse arguments. Inference includes gathering information, alternative allegations, and making conclusions. Evaluation includes the assessment of claims and assessment of



arguments. Explanation includes stating the results, justifying a procedure, and presenting arguments. Self-regulation includes examination and self-correction.

The development of Science and Technology in the 21st century progress in various aspects of life. The rapid development of science and technology impacts on the change and improvement of learning [7]. The development of technology in education requires the assessment process to be more effective and efficient. In this century, a variety of computer-based media is found to complete the assessment process and assist in the advancement of classical assessment [8]. Computers have been selected for the development of science and technology and have various advantages [9]. Some research explains that conventional tests only provide information on a limited aspect of creativity [10]. CBT suggest an impact on learning strategies, where few studies show that CBT is a versatile educational tool [11]. For this reason, a test was developed that provides accuracy and can measure the ability of each student, which is a computer-based test (CBT).

The main purpose of education is not only to teach basic knowledge, but to use the thinking skills such as creative thinking skills [12], problem-solving skills [13], scientific and technological capabilities [14],[15] because this is a necessary skill for sustainability and education lifetime. In addition [16] also predicts that in the future, the world will become more complex with problems that require new solutions. Therefore critical and creative thinking are essential. In addition critical thinking enables students to evaluate evidence, assumptions, logic, and language underlying the statements of others [17].

In Indonesia, the 2013 Curriculum includes technology as an assessment pattern through UNBK. In this context, physics should be taught, so that critical thinking skills can evolve to solve real-life problems using PhysTeCTS-CBT. In this study, an innovation of CBT integrated with item response theory (IRT) has been explored.

2. Research method

This is a developmental research using the 4D model [18]. However, in this case, the development only reaches the third step. PhysTeCTS-CBT development phases include: 1) defining the concepts needed; 2) The initial design of CBT; and 3) development of CBT. To find out the results of the agreement of the experts we used the categories of PhysTeCTS-CBT feasibility in table 1 [19].

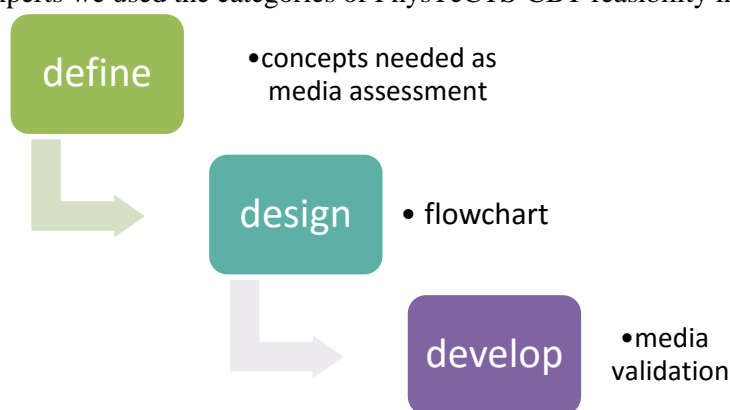


Figure 1. The stages of the 4D-model.

Table 1. The criteria of feasibility media.

Interval	Categories
$X > \bar{X} + 1,8x Sb_i$	Very good
$X_i + 0,6x Sb_i < \bar{X} \leq X_i + 1,8x Sb_i$	Good
$X_i - 0,6x Sb_i < \bar{X} \leq X_i + 0,6x Sb_i$	Sufficiently
$X_i - 1,8x Sb_i < \bar{X} \leq X_i - 0,6x Sb_i$	Low
$\bar{X} \leq X_i - 1,8x Sb_i$	Lowest

3. Results and Discussion

Critical thinking skill tests are developed based on aspects and sub-aspects of critical thinking skills described in [5] which gives a simple explanation aspects of building simple skills, concluding, providing further explanation, as well as set the strategy and tactics. As many as 136 item two-tier multiple choice model input test on PhysTeCTS-CBT was developed. The define step shows that PhysTeCTS-CBT is needed as physics assessment for measuring critical thinking skills. The result of the design step is given in a flowchart of the PhysTeCTS-CBT that can be seen in figure 2.

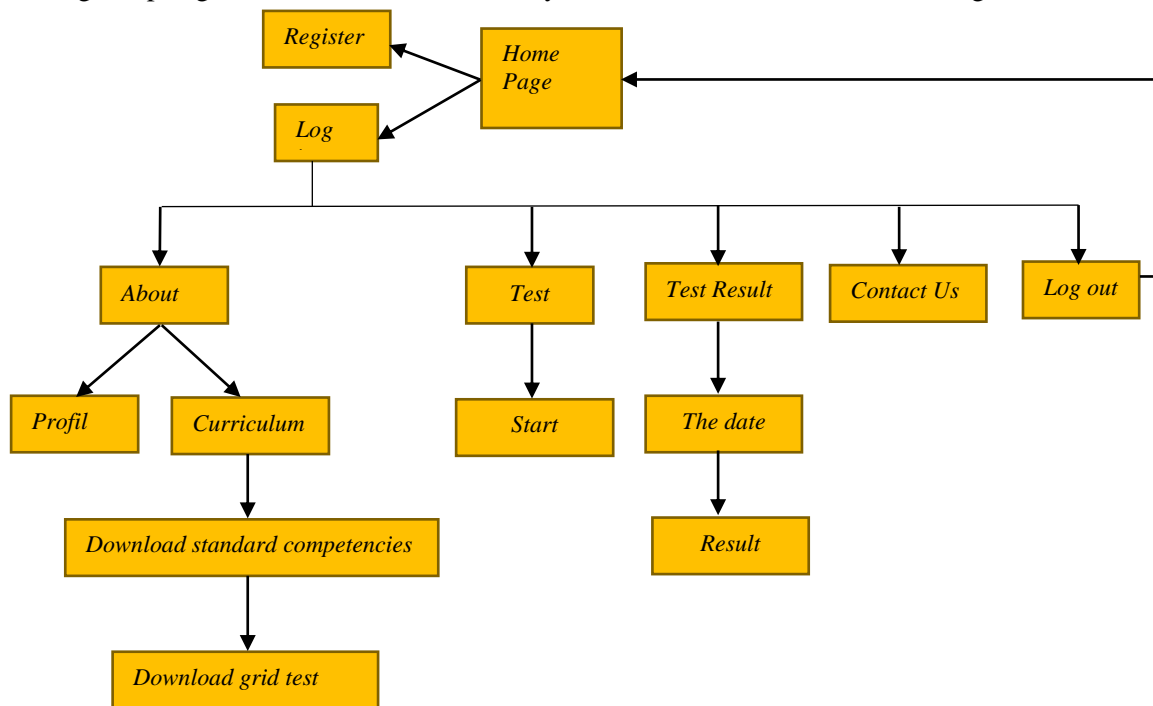


Figure 2. Flowchart of PhysTeCTS-CBT.

The CBT media has been developed containing the critical thinking skill tests that are packaged into the PhysTeCTS-CBT. The PhysTeCTS-CBT opening page contains two options of the critical thinking skills test instrument. Admin page is the implementation of a storyboard, designed as an access to the main display. To log in to the admin page the admin must enter a username and password as shown in Figure 3. After entering the username and password the display appears as shown in Figure 4. On the menu there are Home Admin page, Master Data, and Recap Report. On the main page of the admin, user can also change the data such as name, email, phone number, and changing the profile photograph as shown in figure 5.

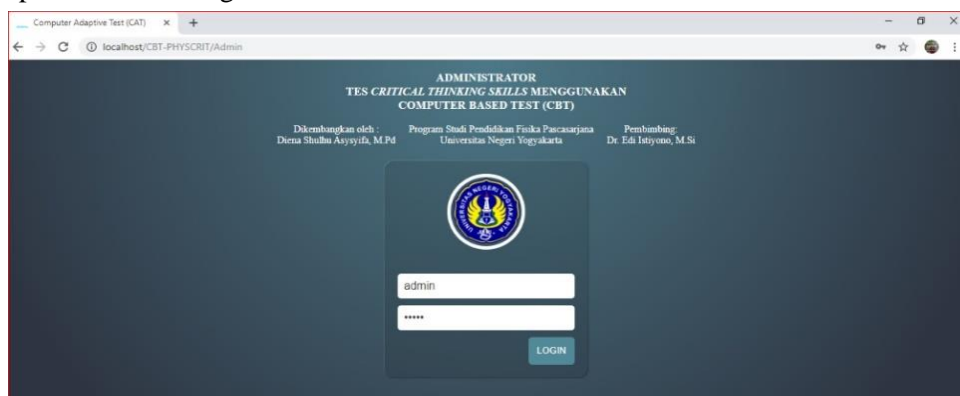


Figure 3. Admin login page.

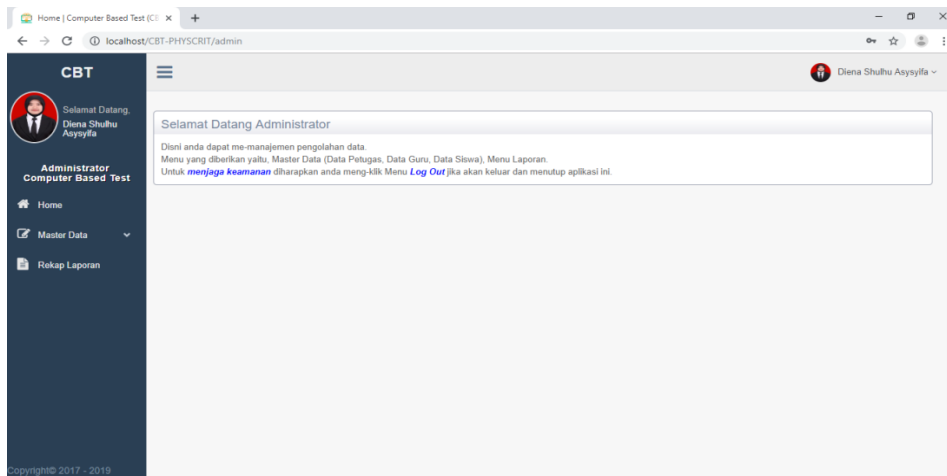


Figure 4. Admin home page.

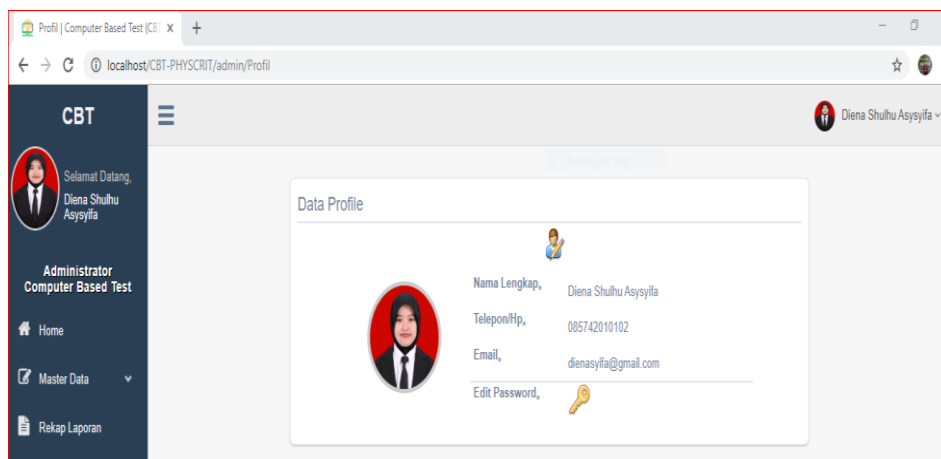


Figure 5. Admin profile display.

The student page on CBT media displays the Home menu, a list of tests, and test results, which may be observed in Figure 6. Students have to click the menu lists tests to start the test, and then shown the test regulations to be read before taking the test. Once the regulation is read, the test may then be conducted so that students can click on the start menu as shown in figure 7. After the start button is clicked then students are presented with items as in figure 8.

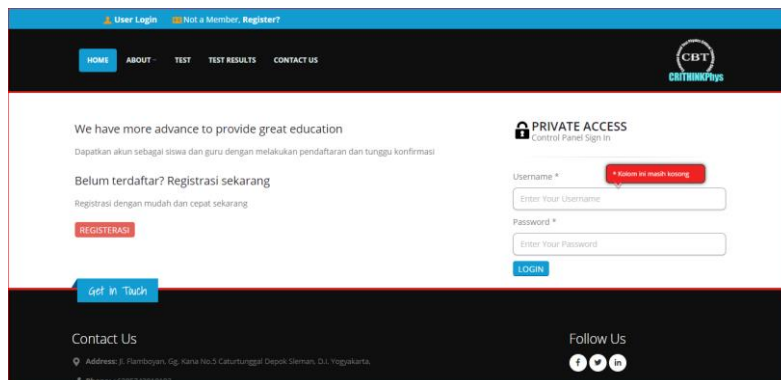


Figure 6. Page students.

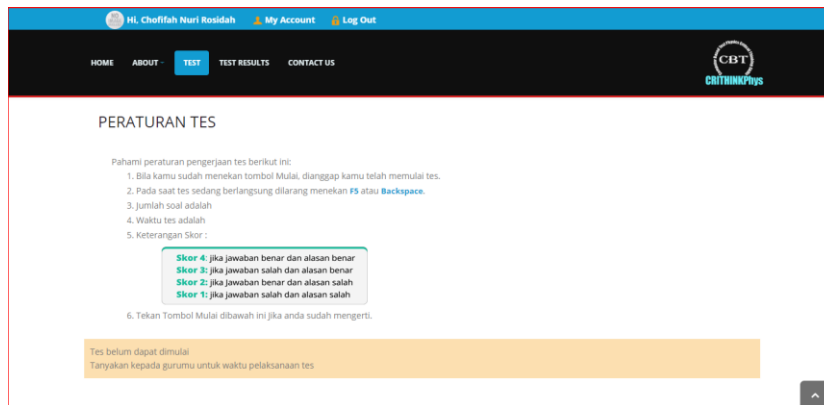


Figure 7. Page test students.

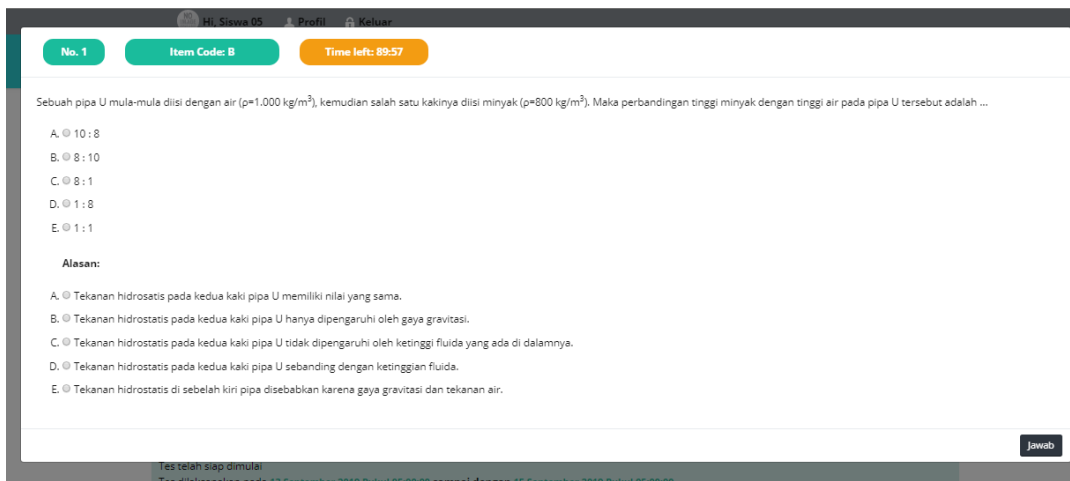


Figure 8. Display item test.

After doing the test, students can immediately see the test results through the ‘test result’ menu. The test result on the student page contains an individual test recap that looks the same as the display on the admin page in Figure 9.

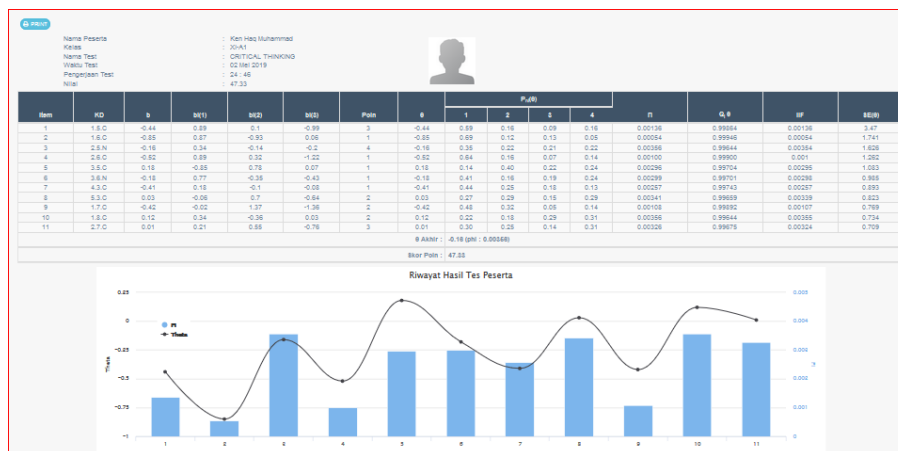


Figure 9. Display test result.

The final stage is determining the level of feasibility of the PhysTeCTS-CBT based on experts' judgment. To determine the suitability of the designed CBT and the critical thinking skill tests to be measured, media validation is carried out involving three experts. Each expert provides an assessment and advice on PhysTeCTS-CBT that have been designed on the media validation judgment sheet. The feasibility of PhysTeCTS-CBT has been examined on the aspects of correctness, reliability, integrity, usability, interface, and navigation. The results of media validation can be observed in table 2.

Table 2. The results of the PhysTeCTS-CBT validation.

Aspects	Mean Score	Category
Correctness	1.00	Very good
Reliability	1.00	Very good
Integrity	1.00	Very good
Usability	0.89	Very good
Navigation	0.73	Good
Interface	0.87	Very good
Average	0.91	Very good

The average score obtained is 0.91 out of a maximum score of 1.00 on the aspects of correctness, reliability, and integrity, so that based on the categories [19] it is found that the feasibility of PhysTeCTS-CBT is very good. Based on study conducted in [20] the CBT effective development depends on the perception of test subjects. The implementation of CBT is done based on consideration that students should be encouraged to be more familiar in using computer and internet in their daily lives [21]. These results refer to the conclusion that PhysTeCTS-CBT is effectively used and the results are consistent with previous relevant research.

4. Conclusion

The developed PhysTeCTS-CBT is feasible to be used. Based on the judgment of experts, it is known that all the aspects of the media feasibility have very good categorized characteristics.

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