DEVELOPMENT OF ONLINE-BASED COMPUTER BASED TESTING (CBT) TO MEASURING CONCEPTUAL KNOWLEDGE OF PHYSICS STUDENT AT SMA CT FOUNDATION MEDAN

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Abstract: The purpose of this research is to develop a system application Computer Based Testing (CBT) online to measure the conceptual knowledge of high school students in Medan. The research subjects were SMA CT Foundation Medan with a total of 48 people. This type of research is the development of research (*Research and Development / R&D*) Van De Akker consisted of 4 steps, *Preliminary Research, Prototyping Stage, summative Evaluation and Systematic Reflection* and *Documentation* using qualitative and quantitative analysis techniques. Based on data analysis, the test instrument totaled 30 items that met the instrument's eligibility standards including content validity with an average value of 81.35 or valid, in terms of the validity of the items obtained rcount of 30 items above 0.17 and 5 items below 0.17 which means that as many as 30 items meet the validity of the items. Judging from the reliability of 0.9 which means the test has good reliability. Judging from the discriminatory power, 16 questions are in the very good category, 10 questions are in the good category, 5 questions are in the sufficient category and 4 questions are in the bad category. Judging from the level of difficulty obtained 14 items in the easy category, 19 items in the medium category and 2 items in the difficult category. Judging from the effectiveness of the distractors, there were 6 items in the very good category, 6 items in the good category, 8 items in the sufficient category, 11 items in the poor category and 2 items in the bad category. The developed CBT system application meets the eligibility of Information and Technology (IT) experts of 86.6% in the very good category. Based on the evaluation of respondents' responses, 86.9% were rate as very good category. From the data analysis, it was concluded that the online-based CBT system application could be used to measure the conceptual knowledge of students at SMA CT Foundation Medan.

Keywords: Computer Based Testing, Conceptual Knowledge

1. Introduction

At the beginning of 2020, the world was experiencing a health threat situation from the Corona virus outbreak (Covid-19) which infected almost all countries in the world. WHO declared the world was entering a global emergency. This also happened in Indonesia so that the Government has issued a disaster emergency status. One of the policies that must be adhered to is that all learning activities at school and outside the home must be replaced with online *learning and work from home*. Starting from the elementary school level to the university level, they must work together to carry out this activity, which cannot be confirmed until when it will take effect because they are still looking at the situation of the spread of the Corona Virus. Therefore, the development and implementation of the lecture system and online-based test exams are expected to be carried out properly.

Especially for the application of an-based assessment system online, it is carried out by carrying out a computer-based test (*Computer Based Test / CBT*). So far, the test is conventional in nature using paper media (*Paper Based Test / PBT*). Novriati (2014) stated that currently conventional exams using paper media are no longer effective and must shift towards computerization. Therefore, along with the times, tests should be carried out by utilizing information technology and during this Corona pandemic, the implementation of-based CBT *online* can greatly assist the student assessment process.

CBT is a transformation of changes from aspects of learning and curriculum in the world of education (Scheuermann& Pereira, 2008) which has developed rapidly, especially in educational assessment (Piaw, 2012). The CBT instrument has added value compared to the *Paper Pencil Test* (Martin, 2008). The CBT instrument is able to package questions more effectively and efficiently thereby reducing paper costs and is equipped with a facility scoring so that a quick and precise assessment can be made. Values that are immediately known by test participants

can be used for self-evaluation. In addition, the CBT instrument has a working time that will stop automatically according to the time setting so as to encourage children to focus more on answering questions because there is no opportunity for cheating. Furthermore, CBT is not only an alternative method of assessment; it is able to train students' self-confidence both before and after taking the test (Jimoh, Shittu& Kola, 2012).

One SMA / SMK / MA also apply online learning (*online*) during a pandemic Corona are seeded CT High School Foundation. This school has been established since 2015 with all the facilities owned by the school such as computer lab, language lab, physics lab, chemistry, biology, library, healthy canteen, polyclinic, basketball court and volleyball court. Especially for IT facilities, this school has Wi-Fi for easy online learning and you may learn more about the school information by visiting the website, smactf.sch.id. Based on an interview online with one of the Physics teacherson May 11, 2020, information was obtained that the school continues to try to adapt the curriculum applied to the development of science and technology, one of which is learning *online* but for the implementation of exams that are based *online* is still just a discourse and has not been fully implemented.

Based on the conclusions of the results of a questionnaire conducted online on 25 first grade students of CT Foundation High School FY 2020/2021, data on satisfaction and responses regarding the assessment system for Physics lessons was obtained, namely 76% of students responding to teacher assessments that were still subjective (sometimes lecturers gave different grades for the same answers from students), students rarely get feedback from the results of their assignments and exams, there are still opportunities for students to collaborate, especially if only one type of question is tested, and the use of time for conducting exams is not effective. This problem arises because the test method used is still conventional, namely the PBT method. According to Himah, Sudarti and Subiki (2016), conventional test formats such as PBT have several weaknesses, namely the assessment process becomes less thorough resulting in assessment errors, the instrument is less effective and efficient and not *up to date*. More deeply, Oluwatosin& Samson (2013) state that the PBT method can cause deviations in the individual character values of educators and students including exam questions that are easy to leak, prone to dishonesty during exams, and bribery to get questions.

In the development of education, the assessment system must be able to adapt to technological developments using computer media such as *Computerized Based Testing* (CBT). CBT is a transformation of changes from aspects of learning and curriculum in the world of education (Scheuermann& Pereira, 2008) which has developed rapidly, especially in educational assessment (Piaw, 2012). CBT instruments have added value compared to PPT (Martin, 2008). The CBT instrument is able to package questions more effectively and efficiently thereby reducing paper costs and is equipped with a facility *scoring* so that a quick and precise assessment can be made. Values that are immediately known by test participants can be used for self-evaluation. In addition, the CBT instrument has a working time that will stop automatically according to the time setting so as to encourage children to focus more on answering questions because there is no opportunity for cheating. Furthermore, CBT is not only an alternative method of assessment; it is able to train students' self-confidence both before and after taking the test (Jimoh, Shittu& Kola, 2012).

Characteristics of Physics subjects are conceptual knowledge, many physics materials contain concepts that students must understand before applying them in everyday life. This is so that students do not experience misconceptions. As an effort to train mastery of physics concepts, the CBT method can be used on routine assignments and material exams. This can help educators carry out assessments more effectively and efficiently and be able to train the character of students such as thoroughness, perseverance, honesty and confidence. These character values can be built from the process of carrying out tests using the CBT method.

The implementation of test exams with the CBT system in Physics subjects is expected to encourage students to be more independent and more focused by continuing to train themselves to use technology in learning because students are required to work on assignments and CBT-based exams. Students who are not proficient in using computers will try hard to practice and students who are skilled will continue to enrich themselves with technological developments, especially the use of computers. The efforts of these students can indirectly increase the conceptual knowledge of physics material and build their own character. The use of computers as a medium in carrying out assignments and exams is an effort to familiarize students with interacting with technology, utilizing Information and Communication Technology (ICT) for *self-assessment*, increasing *ICT-literacy* and *ICT-usability* and strengthening learning through practice exams (test learn by the).

As a continuation of the 2019 research, in this 2020 research design, the Research Team intends to apply CBT at the CT Foundation High School Medan City by adjusting the characteristics of learning and students at the school. It is hoped that the CBT product will be useful for making exams effective online. In addition, the research team believes the results of this study will provide benefits for improving the quality of online assessments amid the implementation of policies to prevent the transmission of the Corona Virus. Based on this, the aim of this research is to produce an-based CBT product online that is suitable for measuring students' conceptual knowledge at CT Foundation's Superior High School and to determine the feasibility of the product so that it can be used to measure students' conceptual physics knowledge.

2. Method

The research method used in this study is a research and development (method R&D) with the development stages of Van de Akker (2006). The development method aims to produce design principles that can be used to solve problems in the field of education (Akker, 2006) consisting of four stages, namely *Preliminary Research, Prototyping Stage, Summative Evaluation and Systematic Reflection* and *Documentation* using qualitative and quantitative analysis techniques. Figure 1 below:

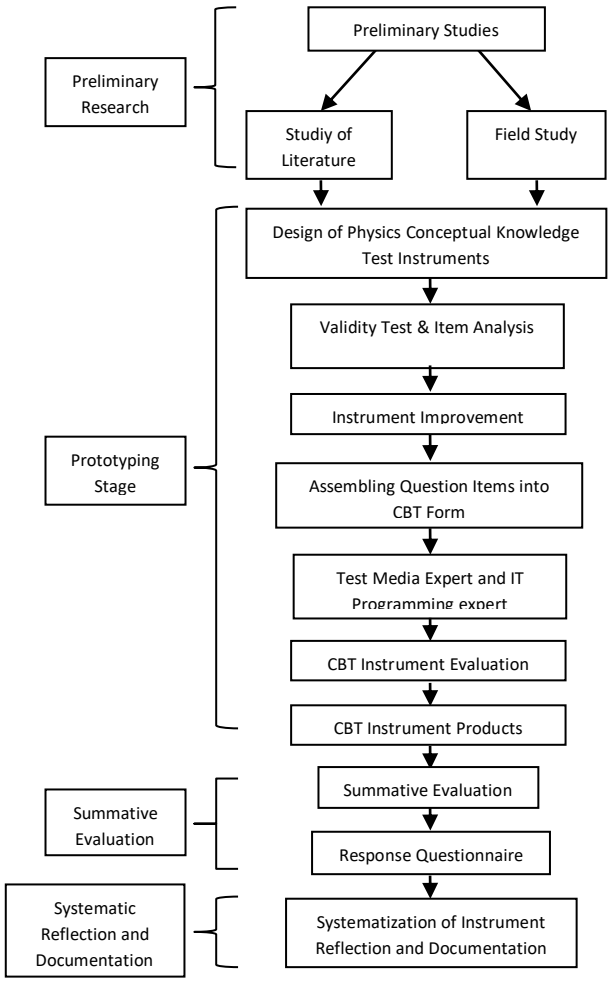

Figure 1. Research Chart

3. Results and Discussion

Preliminary research Stage

This stage is a preliminary study which includes the collection of documents on preliminary data and research needs such as data core competencies (KI) and the Basic Competency (KD) and indicator Matter Physics high school

level, the source physics material for making questions, guides for developing test instruments and guides for developing computer-based test models. Furthermore, the preparation of instrument development designs, test application system designs, test instrument validation sheets and test participant response sheets was carried out.

The results obtained from this stage are the formulation of KI and KD, the research instrument is in the form of a test instrument validation sheet, and the test response sheet.

Prototyping Stage Phase

The Prototyping Stage is the second stage, which includes designing items, validating questions, designing online-based test systems utilizing computer applications, analyzing system validity, and performing trials with test participants. The validation assessment of the product is the basis for improving or accomplishing product so that is interesting and feasible to use (Tanjung, Panggabean&Sudama, 2018).

Draft items are limited to the material before the Middle Semester Exam (UTS) that is material Electric Dynamic, Static Electricity and Magnetism, totaling thirtyfive items.

Based on the instrument grid, the questions were compiled. Then the test instrument of thirtyfive items were validated through the content validity method by two experts in the field of material and learning evaluation using a validation assessment sheet.

Based on expert suggestions and comments, improvements were made to the questions so that the conclusion of validity was obtained in Table 1

Table 1 Results of the Expert Validation Review

	Validator 1	Validator 2
Value	82.15	80.56
Average Value	81.35	
Conclusion	Valid (may be used with minor revisions)	

Table 1 shows the test instrument can be used with minor revisions with an average score of 81.35. So the next step is to revise the test instrument based on suggestions from the Validator. After revision, the test instrument can be used to test the validity of the forecast and the reliability and analysis of the items.

Based on the results of the analysis of the validity of the forecast, it was found that the questions that were included in the valid category were 30 items while the questions that were not valid were 5 items. From these results, 5 invalid questions could not be used for further testing, so the questions were discarded. In Table 2, the results of the validity analysis are presented.

Table 2 Validity Analysis Results

Validity	Item	Total Items
Valid	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23 , 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34	30
Invalid	3, 12, 15, 34, 35	5

The reliability analysis technique uses the formula *Kuder-Richardson-20* or KR-20. Based on the results of the calculation, the reliability of the item was 0.9, meaning that the test used already had good reliability.

The results of the analysis of the level of difficulty of the test instrument from the results of a wider field test obtained 14 items (40%) in the easy category (p> 0.7), 19 items (54%) in the medium category (0.3 p 0, 7), and 2

items (6%) in the difficult category (p < 0.3). The results of the analysis of the level of difficulty of the test instrument from the results of the wider field test can be seen in table 3.

Table 3 Results of The Analysis of The Difficulty Level of The Wider Field Test Questions

Category P	Number of Items	Total Items
Easy (0.71 < P 1.00)	1, 2, 4, 6, 7, 8, 9, 10, 11, 13, 14, 21, 22, 23	14
Medium (0.31 P 0.70)	3, 5, 12, 15, 16, 17, 18, 19, 20, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33	19
Difficult (P < 0.30)	34, 35	2

The analysis of discriminating power of items aims to distinguish between students who have high abilities and students who have low abilities, or to distinguish the upper and lower groups. The results of the analysis of the differentiating power of the test instruments can be seen in table 4.

Table 4 Differentiating Power of Questions

Category	Item Number	Total Items
Very good (0.50 – 1.00)	2, 4, 6, 7, 11, 12, 15, 17, 18 , 19, 20, 21, 23, 27, 30, 31, 33	16
Good (0.30 – 0.49)	5, 13, 14, 16, 24, 25, 26, 28, 29, 32	10
Fair (0 ,20 – 0.29)	1, 3, 9, 10, 22	5
Poor (< 0.19)	12, 15, 34, 35	4

The effectiveness of the distractors in an item is analyzed from the distribution of answers to the item in question in each alternative provided. The distractor is said to be effective if it is answered by at least 5% of the participants and more are chosen by groups of students who do not understand the material. Meanwhile, in terms of turnover, a test is said to be good if the turnover is not more than 10% of students (Kadir, 2015). The results of the recapitulation analysis of the effectiveness of the distractors can be seen in Table 5.

Table 5 The results of the Problem Distractor's Effectiveness

Effectiveness of the distractors	Item Number	Total Items
Very good	24, 27, 29, 30, 31, 32,	6
Good	11, 16, 18, 19, 23 , 33	6
Fair	5, 6, 7, 13, 15, 17, 25, 28	8
Poor	1, 2, 3, 4, 8, 9, 10, 12, 14, 20, 26	11
Not Good	21, 34, 35	2

Based on the overall feasibility test, it was concluded that the questions that met the eligibility criteria and were acceptable were 30 items and the questions that did not meet the eligibility criteria and could not be accepted were 5 items.

Online-Based Test System Design

The next activity is the online-based CBT system design. The following are the results of the online-based CBT system design.

Display Design

At first, the researcher developed a CBT system with a special domain with a choice of link name http://Physicssmart.comwith Moodle. The following is the design of the page display when the user accesses and logs into the system in Figure 2.

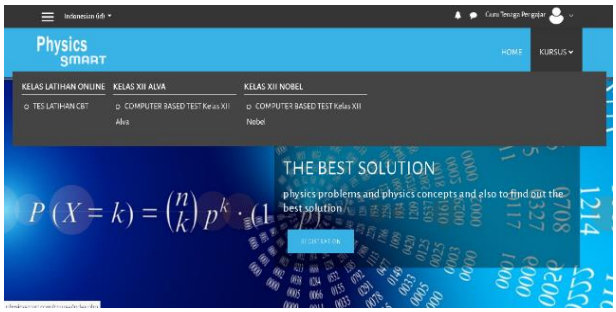

Figure 2 Initial Display Design

To start the quiz students must enter the code (Password) to start the exam, as in Figure 3 and students will be directed to the test homepage to start the exam, as in Figure 4.

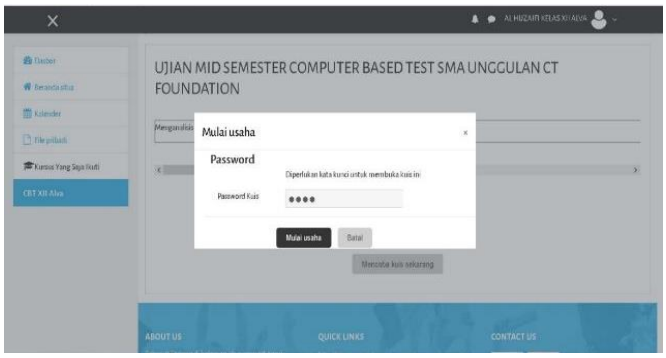

Figure 3 Test Start Display

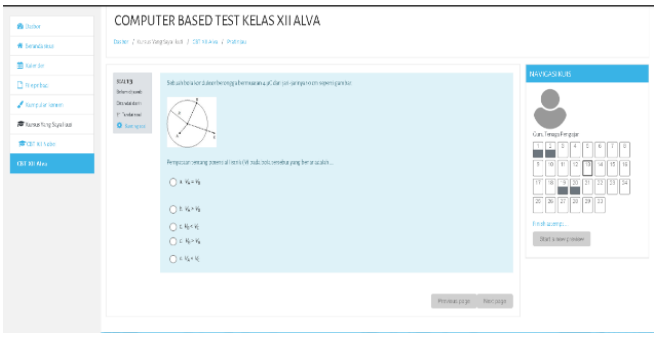

Figure 4 Test Display

After all questions have been answered, students are required to click the Finish button to end the test. After the student ends the test, the student can no longer continue the test and the student's score will automatically come out. The final display of the test can be seen in Figure 5 and the display of the final test scores in Figure 6

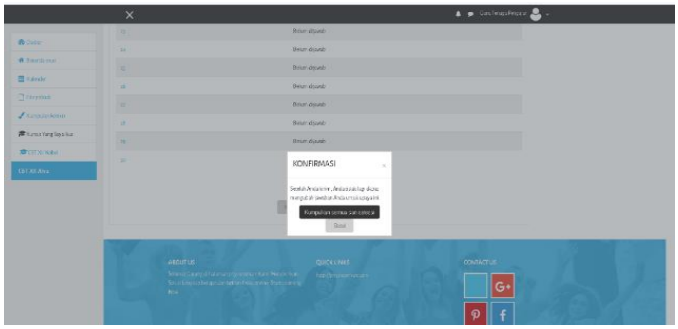

Figure 5 Final Display of the Test

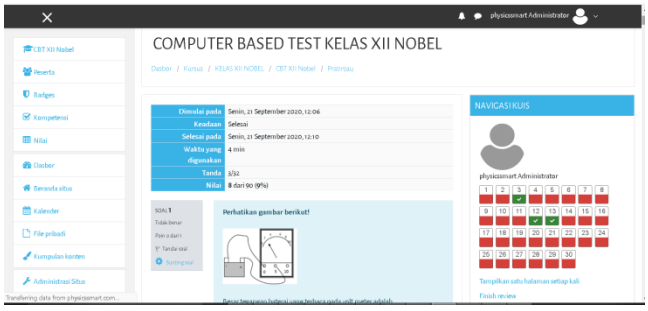

Figure 6 Displays of Test Values

At the implementation stage, the system was tested by IT experts to determine the feasibility of the developed system. In addition to the assessed components of the assessment, experts also provide comments and suggestions for improvements to the products developed. The comments and suggestions from the experts are listed in Table 6.

Table 6 Comments and Suggestions from the Validator

No.	Validator	Comments and Suggestions
1	IT Expert 1	Feature display on the application homepage is not easy user yet
		The final score conversion is still wrong, adjust it to the number of questions
		There are still incorrect questions
2	IT Experts 2	Initial display, reflects test activities
		Exit button is not maximized
		Admin login page and lecturers are put together.

Based on Table 6, there are descriptions of improvements from the two IT experts on several indicators starting from the initial display that does not meet the test activity indicators, the display of the final score that has not been read, the interface display that is less attractive and less interactive. In the content indicator, there are syntax errors such as typing errors in sentences in the system, navigation layout, content and functions that have not been placed properly so that it can be difficult for users.

Based on these suggestions, the developer made improvements to the test system and then retested by IT experts covering aspects of content, interface, navigation, configuration, and security which had been converted into the assessment category and the results were obtained in Table 7 below

Table 7 Data on Assessment Results by IT Expert

Component Assessment	Percentage (%)	Category
Content	70.8	Good
Interface	96.6	Very Good
Navigation	87.5	Very Good
Configuration	75	Good
Security	91.7	Very Good
Average	86.6	Very Good

Based on Table 7 it is known the average percentage from two IT experts for the Content aspect, 70.8% were in the good feasibility category, the Interface aspect was 96.6% in the very good category, the Navigation aspect was 87.5% in the very good category, the configuration aspect was 75% in the good category and the security aspect by 91.7% very good category. Based on the average value of all aspects, it can be concluded that the feasibility level of the CBT system is 86.6% in the very good category. From these results, the system that has been developed is feasible to use because it has met the testing by IT experts.

Based on these suggestions, the developer made improvements to the test system and then re-tested by experts in the media field covering aspects of correctness, reliability, integrity, and usability, the results are shown in Table 8.

Table 8 Assessment Results in the Media Field

Component Assessment	Percentage (%)	Category
Correctness	72.5	Good
Reliability	90	Very Good
Integrity	85.5	Very Good
Usability	77	Good
Average	81.3	Very Good

Table 8 represent the media assessment includes Correctness of 72.5% with good category, reliability of 90% with very good category good, integrity is 85.5% in the very good category and usability is 77% in the very good category so that the average for the overall media assessment is 81.3% in the very good category. Based on the assessment of the IT and Media fields, online-based CBT products are suitable for use by students. This result is same with research Tanjung, et al (2021), This shows that the system (CBT) can be relied on to measure students' conceptual knowledge.

Furthermore, a trial was conducted on users, namely 48 students of SMA CT Foundation Medan based on the correctness, reliability, integrity, usability and usefulness assessment indicators. The results of the student response trials are presented in Table 9.

Table 9 Results of the Test Response

Component Assessment	Percentage (%)	Category
Correctness	70.8	Good
Reliability	96.6	Very Good

Integrity	87.5	Very Good
Usability	75	Good
Usefulness	91.7	Very Good
Average	86.9	Very Good

The results obtained from testing the user's response of 86.9%, meaning that the user gave a very good response to the CBT system product. Based on the results of the assessment of the IT field, media and user responses, the final product in the form of an online-based CBT test system can be used because it has met the standard test of the feasibility of a good test instrument and the system's feasibility test. Furthermore, this system can be installed and run on a network server.

4. Conclusion

The conclusion obtained is that 30 test instruments have been prepared which have met the eligibility criteria for a good instrument including validity, reliability, levelof difficulty, discriminating power and effectiveness of distractors. An online-based CBT system has been developed on Physics material that meets the qualifications of IT experts and student responses so that it can be used to measure the conceptual knowledge of SMA CT Foundation Medan students.

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