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Nurturing Innovative and Highly Literate Generation through Science Education



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PREFACE

Praise to Allah SWT for all the blessings and guidance given to us all, so that the program of the International Seminar on Science Education (ISSE) 2016 book with the topic about *Nurturing Innovative And Highly Literate Generation Through Science Education* which held on October 29th 2016 at Rectorate Hall, Yogyakarta State University can be completed successfully. This book comprises number of abstracts that have been presented in the seminar, written by lecturers and students from Yogyakarta State University and other universities.

We owe many parties for the success of the seminar. Therefore, we would like to sincerely extend our gratitude to:

1. The rector of Yogyakarta State University, Prof. Dr. Rochmat Wahab, M.Pd., M.A. for facilitating all the activities of the International Seminar on Science Education (ISSE) 2015;
2. The director of Graduate School of Yogyakarta State University, Dr. Moch. Bruri Triyonofor providing all the facilities of the International Seminar on Science Education (ISSE) 2016;
3. The invited speakers for their willingness to share thoughts and insights on science teaching and learning in the seminar;
4. All committee members for the time, effort, and thoughts for the success of this activity; and
5. All presenters and participants who have come a long way to contribute to the success of the seminar.

However, we truly fully understand that some imperfections might be found in this book and in the seminar. Thus, suggestions and constructive criticisms are very much welcome. Finally, we do hope that this book can bring some contributions for innovative and highly literate generation through science education.

Yogyakarta, October 29th 2016

Chairperson

Dr. Heru Kuswanto, M.



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THE USING OF COMPUTER AS A TOOL FOR PHYSICS COGNITIVE ASSESSMENT TEST “PhysCoTest” IN 21st CENTURY

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Abstract- The purpose of this paper is to determine the important of cognitive test for student with assisted computer. Computer based test became one of the innovations in the world of education. Cognitive tests in physics learning as a benchmark for educators to know the extent ability of learners achieve competence contained in the curriculum. The use of computer in form of Computer Physics Test "PsyCoTest" as an alternative to prevent cheating and efficiency of scoring test. Basically "PhysCoTest" is part of the Computer Based Test which complement the Paper Based Test. "PhysCoTest" created using Macromedia Flash 8 application and system test is displayed random. Test validated using Item Response Theory (IRT) model, and then the cognitive tests were valid will be packaged into "PhysCoTest" and tested to learners. The use of "PhysCoTest" is important in cognitive tests to help educators and learners in time efficiency test and accuracy of the test results.

Keywords : *Cognitive Test, Computer Based Test, PhysCoTest, Item Response Teory (IRT)*

I. INTRODUCTION

Physics is one branch of science that studies the phenomena of nature through a series of scientific process. Learning physics oriented cognitive abilities, psychomotor and affective. Assessment of attitude and affective character more unique because it is directly related to the character of the students, so that the process of the assessment should also be through direct assessment, whereas for cognitive assessment with regard to the intelligence of the students followed the teaching and learning process, educators can more easily assess what has been accomplished participants learners through cognitive assessment tests using either the Paper Based test (PBT) or take advantage of technological developments by using Computer Based test (CBT). As the days turned out development Paper Based Test (PBT) have some weaknesses, so that the Computer Based Test (CBT) is presented as a complement to the assessment exercise.

Assessment at the level of cognitive domain of Bloom's Taxonomy consists of six categories consisting of Lower Order Thinking Skills (LOTS) include C1, C2 and C3 and Higher Order Thinking Skills (HOTS) include C4, C5 and C6. Taxonomy in education is a scheme for classifying the purpose of education, and standard of the end of a lesson [1]. Assessment can be seen as a tool used to measure learning outcomes, while generally vote seen as a way to determine the value, the extent to which students have achieved the objectives [2].

Tests are planned measurement tool used by educators to provide an opportunity for students to demonstrate achievement and its relation to predetermined objectives [3]. The variation in developing a written test, which is multiple choice, sentence completion, listing, true-false, matching, essay, and a modified form [4]. A cognitive tests created or developed based on Bloom's taxonomy, every aspect of the taxonomic level emphasizes the assessment of learning with many examples of test items (mostly multiple choice) is provided for each category. Teachers so easy to know at what level of knowledge the students).

In practice they are rarely teachers use computer assistance in the administration of the test, while the computer apart as an innovative learning media, can also be used as an effective media ratings. The use of computers in class assessments increasing the interest in assessment which resulted in finding potential varies



between learners [5]. This means that the use of computers in the assessment showed mixed results so that the possibility of the same test results among students to be minimal. Due to the inclusion of ICT in education, it is necessary to reconsider and rethink, modify or alter the traditional inspection methods. electronic assessment tool has reduced the burden on teachers and facilitates to conduct the examination [6]. Computer Based Test (CBT) has many advantages, among others, saving testing time, save costs, reduce cheating in tests, reduce errors in the assessment and feedback the results of the test can be quickly and accurately known [7].

Preparation of the test generally uses classical test theory (CTT = Classical Test Theory). But in the preparation of the cognitive tests used the modern theory of the Item Response Theory (IRT), wherein the preparation of the test does not depend on the sample tests so that the results of the preparation of the test is more accurate. (Hambleton, Swaminathan and Rogers: 2]. The preparation of the tests in modern equipped with presentation of the tests in the modern use of computer Based test (CBT) needs to be done, it is encouraging the process of testing more accurate and efficient. So the use of computers as tools of cognitive tests physics "computer physics test" (PhysCoTest) designed using Macromedia Flas 8 , that of a random question shown. Consistent with these problems, this research is intended to: 1) obtain cognitive test instruments are valid and reliable, 2) generate effective PhysCotest construction used in cognitive tests students.

II. LITERATURE REVIEW

Some of the theories that support the use of computer-related articles as an assessment tool physics cognitive tests include:

A. Assessment Cognitive Test

Principles of valuation and assessment standards emphasize two main ideas that should improve the assessment of learners and assessment is a valuable tool to make teaching decisions [8]. Assessment is not just a data collection learners, but also its processing to obtain a picture of the process and the learning outcomes of students. Dilakukan assessment of teachers as a medium of reflection to determine what action to do next.

Assessment instruments are made must meet the cognitive, affective and psychomotor. During this time we already know the domain of Bloom's taxonomy, especially in the cognitive, usually in the realm of writing is written in C1 stands for cognitive stage of knowledge up to C6. Tests on the cognitive tests used to mengukur intelligence of learners in the learning process, measuring the extent to which understanding of the subject matter is acceptable learners, of cognitive domains are domains that include mental activity (brain) [9].

Bloom creates cognitive domain into six levels, later revised to Bloom's taxonomy revision. Taxonomy comparison of before and after the revision is shown as in Table 1.

TABLE 1. COMPARISON OF BLOOM'S TAXONOMY BEFORE AND AFTER REVISIONS

Older Bloom's Taxonomy	Revised Bloom's Taxonomy
Knowledge	Remember
Comprehension	Understand
Application	Apply
Analysis	Analyzing
Synthesis	Evaluate
Evaluation	Create

But this time to design a test that is not focused on the skills of lower grade, Bloom's taxonomy revisions started to be used, thus analyzing, evaluating and creating including at high-level thinking skills. Test high-level thinking skills are also included into the cognitive tests that high-level cognitive tests. More clearly realm kognitif in bloom taxonomic revision is presented in Table 2.





TABLE 2. STRUCTURE OF THE COGNITIVE PROCESS DIMENSION OF THE REVISED TAXONOMY [1]

1.0 Remember – Retrieving relevant knowledge from long-term memory. 1.1 Recognizing 1.2 Recalling
2.0 Understand – Determining the meaning of instructional messages, including oral, written, and graphic communication. 2.1 Interpreting 2.2 Exemplifying 2.3 Classifying 2.4 Summarizing 2.5 Inferring 2.6 Comparing 2.7 Explaining
3.0 Apply – Carrying out or using a procedure in a given situation. 3.1 Executing 3.2 Implementing
4.0 Analyze – Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose. 4.1 Differentiating 4.2 Organizing 4.3 Attributing
5.0 Evaluate – Making judgments based on criteria and standards. 5.1 Checking 5.2 Critiquing
6.0 Create – Putting elements together to form a novel, coherent whole or make an original product. 6.1 Generating 6.2 Planning 6.3 Producing

The development phase good test as follows: 1) preparing test specifications, including: a) define test objectives, b) arrange grating tests, c) determine the test form and d) determine the length of the test , 2) writing test, 3) examine the test, 4) to test the test, 5) analyzing test items, 6) improvements in the assay, 7) assemble the test, 8) carry out tests and 9) to interpret the test results [10].

B. Computer Based Test (CBT)

The development of Information and Communication Technology (ICT) in teaching and learning has changed the paradigm of ratings [11] from the Paper Based Test (PBT) into a computer-based test that is usually called Computer Based Test (CBT). Bodmann & Robinson (2004), computer-based test offers several advantages over the traditional paper and pencil or paper-based, one of the benefits of CBT is the result of more accurate test and test results faster known student of the use of paper based test that requires a longer time correction.

Methods of using paper and pencil testing is already in a few years ago, but as the development of technology testing method is equipped with electronic media, namely computer. Computer Based Test (CBT). present to complete the lack of testing methods using paper and pencil. Computer Based Test (CBT) has many advantages, among others, saving testing time, save costs, reduce cheating in tests, reduce errors in the assessment and feedback the results of the test can be quickly and accurately known [7].

C. PhysCoTest

PhysCoTest is a product that contains material question banks Temperature and Heat . PhysCoTest created using Macromedia Flash 8. The system developed at PhysCoTest illustrated in Figure 1, PhysCoTest System Flow Diagram.

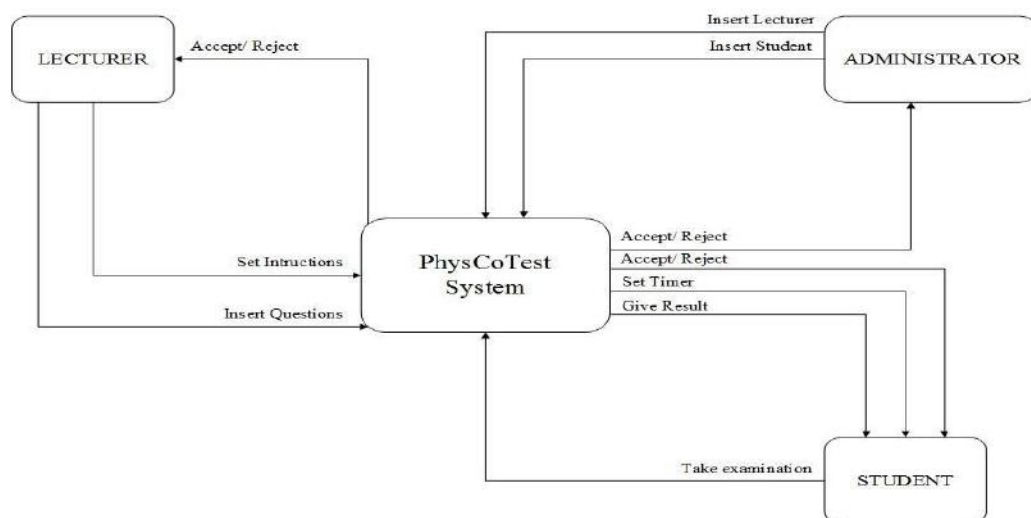
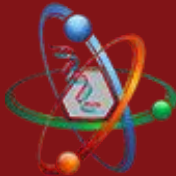


FIGURE 1. PHYSCOTEST SYSTEM FLOW DIAGRAM

III. RESEARCH METHODS

I. Model Development

The development model used is the 4-D, which includes four stages Define, Design, Development and Dissemination [13]. Figure 2 shows the flow development 4D.

II. Trial Design Products

Design of product trials in the study include two packages question the temperature and heat the material, design trial conducted through the stages of validation expert, empirical validation, initial field trials and field trials.

III. Subject Try

Two sets of instruments which have been revised based on input from experts and declared valid, then tested on 250 students of class X Senior High School in DIY.

IV. Data Collection Techniques

Data collection techniques include engineering tests and nontes. Mechanical tests are used to measure the ability to think critically, while nontes technique using a questionnaire to measure the effectiveness of adherence to PhysCoTest.

V. Data Analysis Techniques

Data collection instruments include the validation questionnaire consisting of a questionnaire item development instrument validation test, questionnaire validation PhysCoTest display, as well as the questionnaire responses of teachers and students of the enforceability of the provision of tests using PhysCoTest.

VI. Trial Design Products

Design of product trials in the study include two packages question the temperature and heat the material, design trial conducted through the stages of validation expert, empirical validation, initial field trials and field trials.

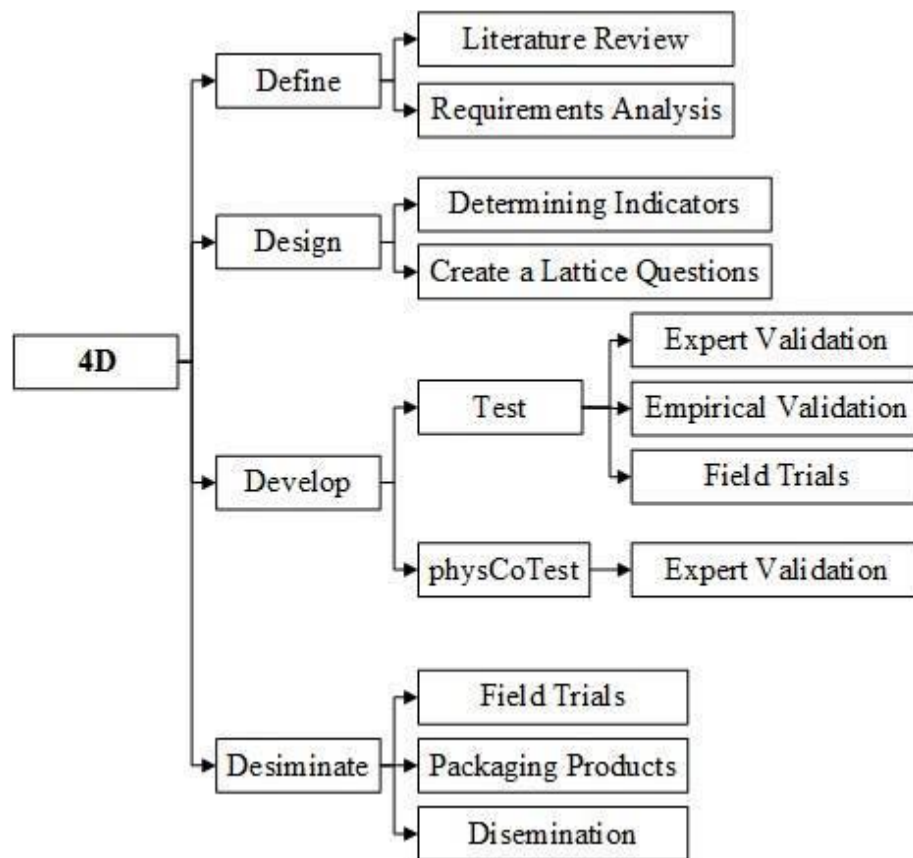


FIGURE 2. FLOW DEVELOPMENT 4D

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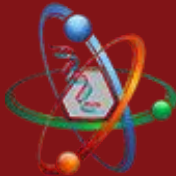
Data collection instruments include the validation questionnaire consisting of a questionnaire item development instrument validation test, questionnaire validation PhysCoTest display, as well as the questionnaire responses of teachers and students of the enforceability of the provision of tests using PhysCoTest.

1) *Instruments Validity*

a) *Content Validity*

Expert validation questionnaire prepared by the interval scale of 1 to 4. Quantitative data is converted into qualitative data. Analysis of questionnaire data validation is performed by the following steps:

- The first step is to find the index V of Aiken [14] using the formula :



$$V = \frac{s}{n(c-1)} \quad (1)$$

Information:

Grading scale from I_0 to c

I_0 = the smallest scale

r = from $I_0 + 1$ to $I_0 + c - 1$

s = total s of n rater

- The second step is the index V Aiken each item questionnaire validity converted into qualitative data with V index ranges from 1 to 0. The validation results declared invalid if the index V Aiken has a value with a range > 0.8 .

b) Empirical Validity

Test instruments that have been declared valid by the experts then tested empirically to learners. Grain tests analyzed using modern theory of Item Response Theory (IRT) model of Rasch (1 PL). Scoring test items using techniques Partial Credit Model (PCM) is a development of the model 1 OT and development of grain dichotomous Rasch model is applied to the grain politomi.

The results of empirical test data were analyzed using the Quest program has met unidimensional assumption test. Determination of criteria validity of each item on the Rasch model-based. Criteria declared invalid item (fit) criteria [15] validation of grain used in the study using the criteria infit mean square (MNSQ), with the criteria of 0.77 to 1.30. Validation whole grains developed by a mean value of INFIT Mean Square (Mean INFITMNSQ) and standard deviation or average value observed INFIT t (Mean INFIT t) and its standard deviation [16]. If the average INFIT MNSQ about 1.0 and 0.0 standard deviation or mean INFIT t approaching 0.0 and 1.0 standard deviation then the entire test fit with the model.

2) Instrumens Reliability

Reliability instrument performed with the help of Quest program, which the reliability test performed by reading the output of sh, the summary of case estimates the value of the reliability of the estimate indicates reliability. The value of the overall reliability of the instruments seen in the output data with the suffix tn, ie on the value of internal consistency.

TABEL 3. INTERPRETATION OF RELIABILITY VALUE WITH RASCH MODEL

Reliability Value	Interpretation of Reliability Value
>0,94	Excellent
0,91-0,94	Very good
0,81-0,90	Good
0,67-0,80	Enough
<0,67	Poor

a) The Level of Difficulty (b)

The level of difficulty (b) for each item is said to be good if the index lurch between $-2.0 < b < 2.0$ were analyzed using Parscale program.

b) Item Characteristic Curve (ICC)

Characteristics of the item indicated by the item characteristic curve (ICC) and the index of difficulty. To get the item characteristic curve (ICC) level of difficulty in each category using Parscale program.

c) The function of Information and SEM

Based on the analysis of the characteristics obtained item information functions and standard error of measurement (SEM). Based on information and SEM functions, then the test is suitable for learners with the ability of low, medium, or high.





3) *The Effectiveness Test Using psychotest*

The development of effectiveness test instruments using PhysCoTest performed by administering a questionnaire on PhysCoTest Teachers. Results of Teachers and students responses were analyzed descriptively. Data analysis was performed by calculating the scores achieved from all aspects assessed [17], is then calculated by the following formula:

$$N = \frac{k}{Nk} \times 100\% \quad (2)$$

Information ;

N = Percentage feasibility aspects

K = Scores on data collection

Nk = Total scores on the data collection

Scores are compared to Table 3 to determine the response criteria teachers and students in applying PhysCoTest.

TABLE 3. RESPONSE SCORE INTERPRETATION TEACHERS AND STUDENTS

Interval Criteria	Criteria Conversion
86 % ≤ N < 100%	Very Effective
72 % ≤ N < 85%	Effective
58 % ≤ N < 71%	Quite Effective
44 % ≤ N < 57%	Ineffective
N ≤ 44 %	Very Ineffective

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