RANDOMIZATION OF MULTIPLE CHOICE QUESTIONS FOR COMPUTER ASSISTED TEST (CAT) IN STUDENT SELECTION

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Abstract

Computer Assisted Test (CAT) is a computer application designed to help selection process, particularly to examine multiple choice questions. This application requires random questions and answer choices derived from a question bank. One of the random number generator is computational algorithms, or the so-called pseudo-random number generators. In this research, the model and randomized algorithm had been developed to generate the initial development of Computer Assisted Test. Linear congruential was used as the method to generate random number. One-sample Chi-Square test was applied to test the model and algorithm for randomness of question items. The statistic test result show $\chi^2 = 206$ *and critical values* $\chi^2_{0.05,199} = 232.19$*, while the number of answer choices for randomness tests statistically obtained* $\chi^2 = 4.0$ *and the critical value* $\chi^2_{0.05,8} = 15:51$*. From both the results of these tests concluded that the randomness of questions and answer choices produce a number of questions and answer choices that number has an equal chance of being selected.*

Keywords : *Computer Assisted Test, pseudo-random number, generator Lehmer*

I. Introduction

Computer Assisted Test (CAT) is a computer application designed to help test or selection process in the management of question bank, generating test items, deliver test results, assessment, reporting results, providing feedback to test takers, etc. Computer Assisted Test is also commonly used to upload a matter or make changes to the records in the question bank.

Random multiple choice test is a condition in which the order of items or questions and the order of the possible answers is a random independent for each participant tests [1]. Test with this models needed for the technical execution of the test with Computer Assisted Test does not have to be done together in the same location, and the execution time can vary. This research will develop algorithms to meet all these random.

II. Review of Literature and Methods

Computer Assisted Test is a model of assessment in which the candidate or candidates to answer questions or provide answers using computer. Moreover the full model is also accompanied by a grading system that is implemented automatically.

Computer Assisted Test can be used for a variety of tests, including: admission test on the selection of new admissions, evaluation of learning outcomes from different levels of education are conducted online, the evaluation of the ability of the company to the employees of the agency or ability in a particular field, or individuals who are interested ability to carry out an assessment for themselves. The test is carried out on a limited location, with online access to the web site, or by purchasing and installing software Computer Assisted Test on a personal computer.

CAT is basically using multiple choice questions. MCQs raw form of two components, namely: a) the stem, and b) an option or choice answers [2]. Stem is a question or an incomplete statement. Contains the option of correct answer or the best choice and a wrong choice or the choice of a lower quality or choice detractors. Anatomy of the multiple choice questions are shown in Figure 2.1.

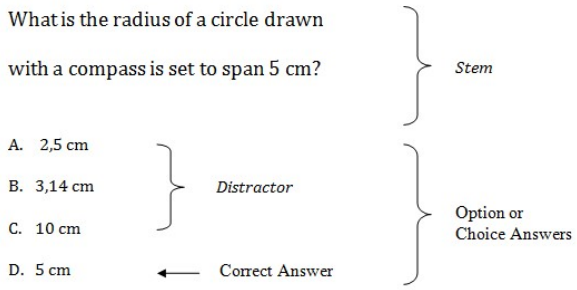

Figure 2.1 Anatomy MCQs

To use the CAT, about randomness and randomness need answers. Obtained about the randomness of random number. Numbers are random numbers generated from a process, which have unpredictable *outcomes,* and can not be reproduced in the same form.

To generate random numbers random number generator used in the form of a computational or physical appliance, which is designed to generate a sequence of numbers that do not appear at random or patterned. Computer-based systems are widely used for this purpose. Sequence of random numbers is a sequence of independent numbers with a certain distribution and a certain probability that is within a certain range of values [6]. Sequence of random numbers generated from random numbers by using a computer algorithm called *psudo-random.*

Algorithms are widely used to generate *pseudo-random* numbers is based on *a linear congruential* random number generator is introduced in 1949 by Derrick Henry Lehmer, and the algorithm would then become a *de facto* standard *pseudo-random* number generator. The algorithm is known with *Prime Modulus Multiplicative Linear Congruential Generator,* or more commonly known as *Lehmer generator* [7].

III. RESEARCH METHODOLOGY

The method used in this study refers to the prototype model of the evolutionary development method of Sommerville [13]. Prototype approach chosen for Computer Assisted Test to test eye was handled very varied and often performed the conversion. Here are the stages of development of the prototype in question:

1. Defining basic needs

At this stage of the development needs of randomized algorithms, both questions and answers are defined. Preparation of various supporters such as the provision of a question bank, the question number index, answer choices was also prepared at this stage.

2. Formulation of the algorithm

At this stage, composed of two algorithms, namely matter and randomized algorithms randomized answer options.

3. Database design

The database is used to store a set of questions and possible answers for each question.

4. Preparation and verification of prototype

This stage is the stage of implementation of the algorithms and database design. Verification is done to check whether the implementation complies with the requirements defined in the first phase.

5. Development of a prototype

In accordance with the concept of evolutionary prototype, the first stage produces the initial version of the prototype, and further developed in a sustainable manner that will produce an evolutionary model that will be used to build a Computer Assisted Test system which is able to be implemented in practice.

IV. DISCUSSION

In the early stages, groomed Lehmer generator first. Lehmer generator can generate a sequence of random numbers with a sizable period, ie for as much as 2^{31-1} numbers. To be able to implement the Lehmer generator, needs to be done a number of preparations, namely:

a. Determining the value of seed or initial value of X n (for n = 0).
b. Normalization R i (i = 0,1, ...).
c. Randomization of questions and answer choices.

In supporting the questions and answer choices randomization, were also prepared question bank, the question number index,

and answer choices. The relationship between these elements is depicted in Figure 4.1.

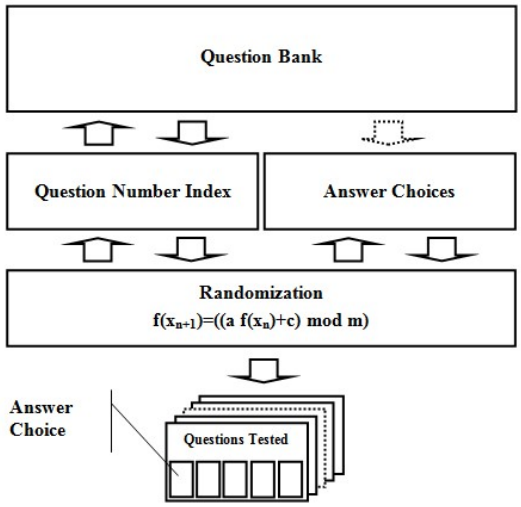

Figure 4.1. The relationship between elements

Then, the algorithm developed, either for randomized and randomized answer choices matter. Both are successively shown by algorithm 4.1 and algorithm 4.2.

```
//Number of questions in the
question bank
tot=jml_soal_all
//Number of questions that tested
n=jml_soal_uji
a=16807
m=2147483647
//Array of numbers about the
tested
nosoal[1,n]
//Array status about numbers
stsno[1,tot]
for i=1 to n
 set nosoal[i] = 0
endif
for i=1 to tot
 set stsno[i] = 'False'
endif
//As seed
x0=round((rand()*m,0)
for i=1 to n
 puter='True'
  do while puter
   xn+1=((mod((a*xn),m))/m)
   urt=xn+1*tot
    //Ensure blm i option to
browse
    if stsno[urt] ='False'
     set nosoal[i] = urt
     set stsno[urt]='True'
     set puter = 'False'
    endif
   set xn = xn+1
  enddo
next
```

Algorithm 4.1. Question Randomization Algorithm

```
//Number of available response
options per question
tot=jml_plh_all
//Number of answers that will be
selected per question
n=jml_plh_soal
a=16807
m=2147483647
//Array containing the number of
answer choices
pilihan[1,n]
urt_k=round((rand() * n),0)
isi pilihan[urt_k] = nomor pilihan
jawaban kunci
// nilai seed
x0=rand()*m
for i=1 to n
 if i ≠ urt_k then
  puter='True'
   do while puter
    xn+1=((mod((a*xn),m))/m)
    urt=xn+1*tot
    sama='False'
    for j=1 to i-1
     if pilihan[j] = urt
      sama='True'
     endif
     next
     if sama='False'
      set pilihan[j] = urt
      set puter dengan  'False'
     endif
     set xn = xn+1
    enddo
   endif
next
```

Algorithm 4.2. Answer Option Randomization Algorithm

To support the implementation of the algorithm, the necessary database. In database design, resulting Question Table, Question Number Index Table, and Answer Choice Table. With the completion of the database design, the prototype can be implemented.

Implementation of randomization using a variety of the following parameters:

1. Subject : 1 unit
2. Question available on question bank : 200 questions
3. Question that needed to be tested : 50 questions
4. Answer Choices available (each question) : 10 options
5. Answer Choices each question required : 5 options
6. The number of test participants (as a sample) : 5 participants

Tested about 200 samples to 5 participants, and each participant gets 50 questions.

To test the results of randomization used test One Sample Chi-Square, because according to Foley [14] test is a test that is commonly used for statistical tests, and widely used for the analysis of random numbers. The equation used is as follows [15]:

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i} \quad \text{..... 1)}$$

Where :

O_i = A lot of cases observed (observed) in the i-th category

E_i many cases expected (expected) in the i-th category under H_0

$\sum_{i=1}^{k}$ the sum of all categories (k)

In the randomization test question numbers will be tested whether each question number (0001-0200) has the same frequency of occurrence for selected. Serial number in the form of a four-digit integer numbers (0001, 0002, 0003, 0004, ..., N) are given for each question were prepared to be tested in the matter of the same group. Here is a summary of tests performed:

1) H_0 : All about the frequency of occurrence of numbers is the same, $f_1=f_2=\ldots= f_{200}$
   H_1 : The frequency for f 1, f 2, ..., f 200 not at all
2) Statistical tests:
   - With the formula as given by equation 1, obtained $\chi^2 = 206$.
   - Since there are 200 categories in the form of numbers that will be checked the randomization, then the degrees of freedom used for the testing of 199 (the number of categories - 1). And with $\alpha = 0.05$ from the Chi-Square Distribution Table values obtained 232.19.
3) Conclusion:

   Because the value of $\chi^2 = 206$ smaller than the value of the table is 232.19 then the conclusion is H_0 is accepted, so that the numbers matter (0001-0200) has the same frequency of occurrence.

Then, in the randomization answer choices, will be tested whether each answer choice number (01-09) have the same chance of being selected. Answer choice in the form of a two-digit integer number (01-09). Numeric selection number 00 is used for the correct answer choice (answer choice key).

Number of about 10 options with a number of possible answers is the answer choice key number (must be selected), so that takes the 9 numbers randomly no answers. Here is a summary of testing randomized answer options:

1) H_0 : all the answer choices frequency of occurrence of numbers (01-09) are the same, $f_1=f_2=\ldots= f_9$.
   H_1 : The frequency for f 1, f 2, ..., f 9 are not all the same.
2) Statistical tests:
   - Using Equation (5) is obtained $\chi^2 = 4{,}00$.
   - Since there are 9 categories of a selected number of questions that will be checked the randomization, then used for testing 8 degrees of freedom (number of categories - 1). And with $\alpha = 0.05$ from Table Distribution Chi-Square value of 15.51 is obtained.
3) Conclusion:

Because the value of χ^2 = 4,00 smaller than the table value of 15.51 then the conclusion is H_0 is accepted, so the number of answer choices (01-09) have the same frequency of occurrence.

V. CONCLUSION

From the research conducted has generated randomization models and algorithms of multiple choice questions in the student selection. This result represents the initial prototype for further use in the development of application systems Computer Assisted Test.

The specific results of this study more are as follows:

1. Lehmer generator can be used to generate random numbers for randomization MCQ admission of students.
2. From the testing with the test sample Chi-Square, k-1 degrees of freedom (number of categories) and α = 0.05 was obtained that the number of questions and answer choices generated numbers each having the same frequency for selected.
3. Despite the question number that appear more than once as much as 37.90% (from 200 to 200 generating random numbers category) and the number of response options that appear more than once as much as 48.00% (from 15 iterations to 9 categories), but with long periods of products Lehmer random number generator, then the condition is still safe to use for multiple choice questions randomization.

VI. REFERENCES

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