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Linear congruent method on computer based test for new student admission

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Abstract. The new admissions examination is an early process in advanced education. Through the entrance examination, the school can select students with the best potential. The exam results can be used as a standard of candidate ability which can further be utilized as a determination of content, methods, and learning strategies. The purpose of this study is to design a system using Linear Congruent Method (LCM) algorithm on the Computer Based Test (CBT) for the new admissions exam. The system build using Waterfall software development life cycle method. The designation of the LCM algorithm is based on consideration of the conformity of the LCM algorithm to be used in the randomization of questions on CBT. The result of experiment shows the ability of LCM to randomize the question and answer of new student admission test is running well, so that the exam process can avoid the cheating of examinees, and on the other hand the assessment can do objectively, quickly, and accurately.

1. Introduction

The development of teaching system is generally known as electronic teaching method or e-learning [1]. Based on their needs, computer-based teaching method is also developed in the test or examination process as an evaluation medium for student success in measuring their academic abilities.

In this study will be discussed about how to manage the entrance examination system to select prospective new students according to their intelligence and abilities. For this reason, Computer Based Test (CBT) is needed, which can maximize the entrance examination activities to assess the ability of prospective new students. If the examination process are conducted manually, the entrance exam questions between prospective students will be most likely always be the same, so that the answer key will be the same also. It can be an opportunity for prospective students to do cheating during examination, such as they ask their friends to answer questions rather than using their own abilities. Because of that, in a computerized system, CBT can randomize questions so that the sequence of questions for each entrance examination test participant will be different. However, this method still allows prospective new students to cheat because the order of answers will remain the same. Therefore, to further maximize the prospective new students in using their own abilities, the answers displayed in CBT will be randomized also. In this way, even though the questions between the test participants are the same, in the order of the answers can be different so that the examinees can be tested to the maximum of their abilities without relying on friends or others.



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Similar studies that have been conducted with regard to CBT-based tests or the Linear Congruent Method (LCM) method are: random algorithms in Computer Based Tests for the acceptance of new students in STTA Yogyakarta [2]; implementation of LCM for spawning enemy [3]; designing an early childhood educational game application using the Android-based with LCM algorithm; and a game-based application for fast typing learning with the LCM algorithm [4]. This study conduct the system designing process for entrance examination using CBT with LCM algorithm for randomize either the questions or the answer choices.

2. Methods

The data in this study are resulted from observation and literature study. Observation is a data collection technique by conducting research and direct review of the research object to get the data that needed [5]. Then, literature studies is the process for data collection by means of literature, journals, and readings that related to research topic. This method is useful to support the basic theory of research that conducted by referring to previous studies. The software design that used in this research is the Waterfall software development life cycle method. Reliability of system applications in this research, it is used: analytical, logical, conceptual, and operational verification by an expert[6].

3. Result and Discussion

The use of information systems in the field of education has shown many successes and built the effectiveness and efficiency of the educational process [7]. Information systems are a combination of information technology and human activities that use computerized technology [8], which is generally used to support operations and management [9]. Information systems are systems that process data in an organized manner [10], information systems have a high degree of flexibility that allows to be developed into better systems [11]. Based on a lot of research results, information systems have advantages in terms of: accessibility [12], efficient in time [13], accurate [14], supporting decision precisely [15], more economical [16], wide accessibility [17], improve user understanding [18], improve productivity [19], better on present the data and information [20], and use data storage media [21].

One of information system implementation in the field of education is CBT. CBT is used as a method of managing and conducting test that conducted electronically. As the name implies, CBT utilizes computers or equivalent electronic devices such as: PCs, smart phones, or PDAs (Personal Digital Assistants). The CBT system allows educators and trainers to write schedules, submit reports about surveys, quizzes, tests, and exams. CBT is a computerized examination mechanism that can be set and programmed as needed [22].

3.1. Linear Congruent Method

A random number model that generated by a computer is a pseudo random number, because its generation uses arithmetic operations. LCM has fast processing time because the operations that are carried out with a few bit manipulation operations only [23]. LCM is a random number generation method that is widely used in computer programs. LCM utilizes a linear model to generate random numbers defined by equation (1).

$$X_{n+1} = (aX_n + C) \pmod{m} \quad (1)$$

Where: X_n = the n^{th} random number.
 a and c = LCM constant number.
 m = maximum random numbers.

The conditions for selecting each parameter in equation (1) are as follows:

- m = modulus, $0 < m$.
- a = multiplier, $0 < a < m$.
- c = increment, $0 \leq c < m$.
- X_0 = initial value, $0 \leq X_0 < m$.
- c and m = relative prime numbers
- $a-1$ can be divided by prime factors of m .

- g. a-1 is a multiple of 4 if m is also a multiple of 4
- h. a m must be very large

3 The characteristic of LCM, and the pseudo random generator generally, is that there is a repetition in a certain time period or after a number of times the generation. Determination of LCM constants number (a, c, and m) greatly determines whether the random numbers that are obtained. The characteristic of LCM is that there is a repetition in a certain time period or after a number of times the generation, this is one of the properties of this method, and the pseudo random generator in general. Determination of LCM constants (a, c, and m) greatly determines whether the random numbers are obtained, the acquisition of random numbers as if there were no repetitions. The LCM implementation framework on CBT is presented in Figure 1.

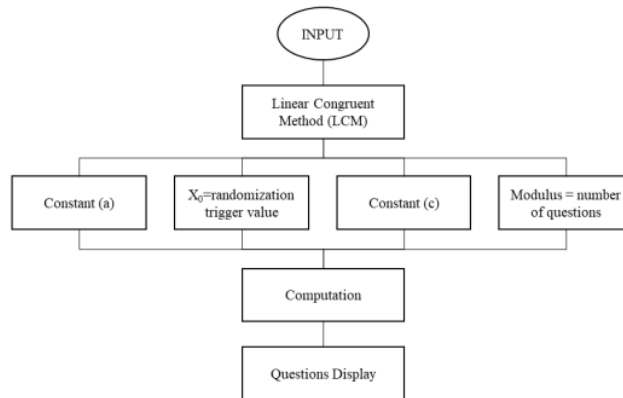


Figure 1. Implementation of LCM Framework in CBT

The stages of LCM implementation on CBT, among others:

- a. Randomization of questions using the LCM method.
- b. The LCM Method input consists of modulus, constant a, constant c, X, which must be assigned according to the requirements of the LCM method to determine constants number.
- c. In computing process, it will be calculated according to the input of the LCM method which has been assigned by automatically generating random numbers according to the calculation of the LCM. Then, the questions in the database will be taken according to the number generated by the calculation.
- d. Last, the question is displayed according to the calculation that has been assigned.

3.2. System Design

The procedure for applying the system are follow the stages:

- a. Log in the page as a participant.
- b. Answer the questions which consist of 60 multiple choice questions, among others A, B, C, D, and E.
- c. Every question has 10 points if answered correctly, and 0 point if wrong.
- d. The results of this test will be calculated based on the average of the correct questions-answers number, the final result score is counted by formula (2).

$$TS = \frac{\text{Jumlah Soal} \times PS}{\text{jumlah Soal}} \quad (2)$$

Where: TS = Total Score
PS = Point

- e. For the predicate rating, categorization is given among others:
 - 1) If the value is ≤ 3.5 then the predicate obtained is "Less".
 - 2) If the value obtained by participants is > 3.6 and ≤ 6.5 then "Enough".
 - 3) If the value obtained by participants is > 6.5 and ≤ 8.0 then "Good".
 - 4) If the value obtained by the participants is > 8.0 and ≤ 10.0 then "Very Good"
- f. For the pass exam participants will be ranked, and are determined based on the predetermined quota.

3.3. System Implementation

The type of questions that is used as the randomization process to be conducted by the LCM process in this study, among others:

- a. Exam questions consist of 60 questions.
- b. Each question consists of multiple choices (A, B, C, D, and E).
- c. Each question has several types of questions consisting of:
 - 1) Word Equations (Synonyms)
 - 2) Opposite the Word (Antonym).
 - 3) Word Relationship (Analogy).
 - 4) Discourse Understanding
 - 5) Series Test.
 - 6) Arithmetic Test.
 - 7) Sub test of Geometry and Arithmetic
 - 8) Logical Reasoning Test
 - 9) Analytical Reasoning Test

The system is designed with a console in the form of a PC, which is displayed by using the user-friendly rules. One of the user interfaces that used in the LCM application on CBT is presented in Figure 2.

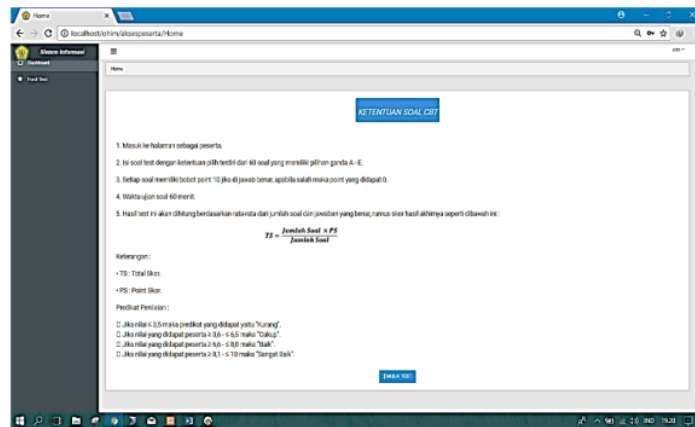


Figure 2. The example of user interface (participant)

The randomization process that occurs in the designed application has several stages to randomize the questions that illustrated in Table 1.

Table 1. Results of Randomization Problem with the LCM method on CBT

Item	1 st Randomization	2 nd Randomization
Participant number	1	2
Name	Aas Astri	Agus Supriatna
X ₀	1	2
M (number of questions)	60	60
a constant number	1	1
c constant number	7	7
Question Index No. 1	$X_0 = (a \cdot X_0 + c) \bmod m$ $X_0 = (1 \cdot 1 + 7) \bmod 60$ $X_0 = 8 \bmod 60$ $X_0 = 8$	$X_0 = (a \cdot X_0 + c) \bmod m$ $X_0 = (1 \cdot 2 + 7) \bmod 60$ $X_0 = 9 \bmod 60$ $X_0 = 9$
Question Index No. 2	$X_1 = (a \cdot X_1 + c) \bmod m$ $X_1 = (1 \cdot 8 + 7) \bmod 60$ $X_1 = 15 \bmod 60$ $X_1 = 15$	$X_1 = (a \cdot X_1 + c) \bmod m$ $X_1 = (1 \cdot 9 + 7) \bmod 60$ $X_1 = 16 \bmod 60$ $X_1 = 16$
Question Index No. 3	$X_2 = (a \cdot X_2 + c) \bmod m$ $X_2 = (1 \cdot 15 + 7) \bmod 60$ $X_2 = 22 \bmod 60$ $X_2 = 22$	$X_2 = (a \cdot X_2 + c) \bmod m$ $X_2 = (1 \cdot 16 + 7) \bmod 60$ $X_2 = 23 \bmod 60$ $X_2 = 23$
Etc.	Etc.	Etc.

3.4. System Testing

In the system testing phase uses black-box testing. The black-box testing is a test based on the function of the program that has been created and the goal is to find the function errors that are in the program. The results of the black-box testing of this system can be seen in Table 2.

Table 2. Result of Testing

No	Testing Items	Testing Scenarios	Expected Result	Result
1.	Share the access account for each User who is in the System	Direct the user on a page correctly, according to the permissions and functions that have been determined.	Able to login according to access account with each user that has different username and password.	(√) Success
2.	Create, update, and delete data on the admin page, participants and questions.	Do create, update, and delete data on the admin page, participants and questions.	Data Created, updated and deleted can function and run properly.	(√) Success
3.	Fill out the test based on the questions and options that available	Filling the existing test items and see the results of the tests that have been done whether its results in accordance with the methods and rules	The system is able to display test questions well and test results displayed according to the rules that have been determined	(√) Success
4.	Calculate the average score value	Calculate the average score value based on the questions that have been filled by the user (participant)	The expected process is in accordance with the average rating that has been made.	(√) Success

Based on the results of the testing, the CBT system for new student admissions that conducted at the Darul Ma'arif Vocational High School (Table 2), it can be seen that all system requirements have been running smoothly, and various forms of cheating can be avoided. Applications can run well for the distribution of access account for each user, test items, and accuracy of the final assessment results.

4. Conclusion

Application design by using LCM in CBT has demonstrated its ability as a device capable of randomizing questions and answers well, and it can be adapted to the examinee. In terms of the randomization method, for further development, the question randomization process can be done by a combination of randomization methods with the LCM method. For system development, it is

recommended to use a more responsive and compatible framework in various media, both PC and smartphone.

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