

Multiple Choice Computer Based Test with feedback, Using Random Number Generator

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Abstrak

Pelajar perlu mengerti dan pendidik perlu mengetahui apakah mereka telah mengajarkan pengetahuan mereka dengan baik, keduanya memerlukan umpan balik. Computer Based Test (CBT) membantu untuk mempercepat pemenuhan kebutuhan umpan balik ini. Beberapa sertifikat profesional juga telah menggunakan CBT, dengan pertanyaan pilihan ganda. Tetapi cara CBT seperti ini, di dalam lab. komputer yang tempat duduknya sangat berdekatan, memberi peluang atau bahkan mengundang orang untuk menyontek. Salah satu cara untuk mengatasi masalah ini adalah penggunaan randomisasi untuk urutan soal yang muncul dan randomisasi untuk letak pilihan jawaban ganda. Di dalam penelitian ini, Linear Congruential Generator (LCG), suatu fitur randomisasi yang terdapat di dalam Visual Basic (MS VB), digunakan untuk membuat aplikasi CBT yang dibutuhkan. Dua jenis aplikasi VB yang dibuat, berdasarkan data MS Access atau MS SQL, telah berhasil diuji coba di Lab. Komputer UPH oleh lebih dari 200 orang mahasiswa, dalam kelompok-kelompok secara paralel (oleh 50 mahasiswa atau kurang untuk subyek seperti: Interaksi Manusia Komputer, Komunikasi Data dan Ujian saring Asisten Lab. Komputer. Tiga tipe hak akses disediakan: administrator, dosen dan mahasiswa. Seusai CBT, pengguna langsung dapat melihat nilainya, di samping ini, dosen pengampu mata kuliah dapat melihat informasi yang berguna, seperti: pertanyaan mana saja yang dijawab salah untuk setiap pengguna-pertanyaan mana saja dijawab salah oleh semua pengguna dan sebaliknya, nilai rata-rata kelas, waktu untuk menyelesaikan CBT, data login-logout, nama komputer, serta IP-nya. Fitur umpan balik lain pada versi akses dosen adalah, kemampuan CBT untuk memberikan pesan kepada setiap mahasiswa, saat CBT sedang berlangsung. Selain CBT meningkatkan persentase pemakaian jaringan komputer, juga telah berhasil dibuktikan bahwa cara yang dipakai untuk menghasilkan urutan soal dan letak pilihan jawaban secara acak tidak mengganggu pemakai CBT.

Keywords: *random, computer based test, education*

1. Background

In any learning process, feedback is an important factor to consider. Educators or examiners need it to determine whether they have transferred their knowledge well. While learners need feedback to measure their understanding of the topics under study. Both parties need feedback – fast enough so that they can proceed to the next topic, having laid good knowledge foundation on previous topic. Conventionally, feedback can be obtained conversationally in a class-room full of students, this is a good method – however not all students are listening at that moment, and the question being posed may not be a subject of

interest. Feedback can also be obtained through written test, however disadvantages of this method are obvious : papers, pens or pencils are used and so time is needed in collating them and in examining each answer paper, not to mention the possibility of human-error in scoring and in entering it into scoring-table manually. Written essay questions are also used and for certain topics and these type of questions are off-course, indispensable.

Multiple-choice questions are an alternative to essay questions, because they provide a wider range of questions, but by no means they replace them. Computer Based Test (CBT) with multiple-choice possible answers, merely helps to fasten this needed feedback. A number of professional certificates issued by relatively big companies, such as CISCO, IBM and Microsoft (MS), have also utilized CBT, with multiple-choice questions. However, this type of CBT in computer laboratories with close-space seating, tempts or even invites users to cheat. One way to overcome this obstacle is by the use of Random Number Generator (RNG). The meaning of RNG here is a mathematical function translated to a programming language, so that both the order of questions' appearance and the location of multiple-choice possible answers are generated randomly. Another short coming of CBT, is the extra work which must be performed to prepare relatively many multiple-choice questions and answers, not to mention, the lack of educators' interest to use computers. However, these advantages can be reduced with the progress of time, team work in making a database of multiple-choice questions and answers, CBT socialization, as well as work in instalments.

2. Problem definition and Research Aims

Feedback is needed by students and educators, and CBT is a potential solution to this need, especially when a computer-network is already available. However, to ensure the validity of the CBT result, randomization feature of the order of questions' appearance and the location of multiple-choice possible answers, must be made available.

The purpose of this research is develop a software which applies RNG in a quiz system, so that as a whole, this CBT can be used to improve the quality of student's learning, by giving faster feedback to students and lecturers. Besides increasing the usage percentage of the already available computer-network, this research also aims to determine whether RNG applied in a certain language may be utilized easily (relatively) and requires unnoticeable delay time to CBT users, to produce random questions from a certain bank of questions. Certain features, must also be included in the CBT application, such as : appropriate security, ability to give feedback to individual students during the test - by giving messages, statistical information (class average score, most difficult questions/questions answered wrongly – vice versa), report printing facility and monitoring capability.

3. Basic Theory

3.1 RNG, a brief historical view

RNG is a basic instrument for stochastic model. Its development has begun since the computer era. The first important method was the middle square method, discovered by Von Neumann in 1946 (Knuth, 1998). In this method, a random number is squared and concatenated on its sides, to obtain the next "random number". Example, 57772156649 – when it is squared, it becomes:

33317792380594909201

and after both of its sides are concatenated, the next number will be:

7923805949

Consequently, this method was insufficient, because it only showed a seemingly random number.

The next important development was introduced by D.H. Lehmer (Deng, 2000 and Lehmer, 1951) and it was called *Linear Congruential Generator* (LCG) in 1951. Lehmer came up with the following equation to produce random numbers:

$$X_i = (BX_{i-1} + A) \bmod m, \quad i \geq 1 \quad \dots\dots (1)$$

Where X_i , B , and A are non-negative integer numbers. The quality of this generator is determined by the increment A , multiplier B , initial value of X_0 and the modulus m . If A is not zero, then there is a possibility to get a full period of m (Deng, 2000). Furthermore, Knuth verified Lehmer findings, and rewrote the equation with four integer numbers, such as:

M	Modulo	$0 < m$
A	Multiplier	$0 \leq a \leq m$
C	increment	$0 \leq c < m$
X_0	Initial value	$0 \leq X_0 < m$

To obtain a random sequence of required number (X_n), it can be shown that

$$X_{n+1} = (aX_n + c) \bmod m, \quad n \geq 0 \quad \dots\dots (2)$$

Equation 3.2 is coined as the Linear Congruential Sequence (LCS). It is also known that determining the remaining of $\bmod m$ is very difficult, and as an example:

The numbers' sequence determined when $m = 10$ and $X_0 = a = c = 7$, is
7, 6, 9, 0, 7, 6, 9, 0,.....

In the previous example, it can be observed that the numbers' sequence does not have to be random for all choices of : m, a, c, X_0 ; this is why it is not easy to make a choice on the number for the required variable in equation 2.

3.2 Random number feature in Microsoft Visual Basic

In this research MS VB's ability to generate pseudo random number, is utilized as a developer tool. The randomize VB function is RND (Microsoft, 2003). It uses the linear congruential method for pseudo random number generation or in other words LCG. The following equation describes the algorithm used:

$$X_1 = (X_0 * a + c) \bmod (2^{24}) \quad \dots\dots (3)$$

Where :

- X_1 = the number produced
- X_0 = the previous value (the initial value used by VB is 327.680)
- $a = 1.140.671.485$
- $c = 12.820.163$

The "MOD" operator in the expression above, returns the integer remainder after an integer division. This differs a little to the LCG method ascribed by Knuth; in this case VB has determined m to be 2^{24} , which compares well to LCG table in L'Ecuyer, 1999. The expression $X_1/(2^{24})$ will then return a floating-point number between 0,0 and 1,0 that is returned by the RND function. Microsoft claims that the sequence of random numbers generated by RND can not be reproduced by implementing equation 3.3, in VB code. This is because internally VB uses an unsigned long data type, which is not supported by the VB language.

3.3 The usage of LCG function in theVB code

The first activity to be implemented in the application is the need for a random order of CBT-questions' appearance. This can be achieved in the following code:

```

• Randomize Timer
RandomArr(0) = (Int(Rnd * ProblemQuantity) + 1)
For b = 1 To RandomNoQuatity
lblRepeat:
C = 0
a = (Int(Rnd * ProblemQuantity) + 1)

```

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For C = 0 To b - 1
If a = RandomArr(C) Then GoTo lblRepeat
Next
RandomArr(C) = a
Next

```

The second activity is to randomize the location of multiple-choice possible answers, this can be obtained through the following code:

```

• Dim X, Y, z As Integer
Randomize Timer
bb(0) = (Int(Rnd * 4) + 1)
For X = 1 To 3
again:
Y = (Int(Rnd * 4) + 1)
For z = 0 To X - 1
If Y = bb(z) Then GoTo again
Next
bb(X) = Y
Next

```

4. Research Method

The method adopted in this research is by experimentation. The sequence of steps taken are: After a short survey of the available CBTs in the market and design considerations stage, a graphical user interface was designed. Following this, the software user requirements, implementation and finally, the actual test in the computer network available. In the initial development, MS Access database had been used then after a series of successful trials, a CBT using MS SQL was developed and tested (Microsoft, 1997 and 2002). Further improvements were added as the experimentation went on, these included: the monitoring and message feedback capabilities.

5. Result and Discussion

5.1 Randomness test

From many sequence of numbers generated by the CBT application, it can be observed that none of numbers were of equal values in comparison to a reference sequence (the 3 tests below, merely serve as examples – actually more tests have been carried out but are not shown here). The numbers shown, were obtained from a bank of 1 to 100 numbers (problem-bank of Computer-Lab. Assistant screening test), but only 30 numbers were taken. A number of the tests had been conducted concurrently by 10 to about 50 students at a time, the result: not one sequence had been the same comparing to others.

```

Test 1 33;6;2;80;49;57;52;1;74;35;86;19;66;68;71;56;8;55;16;75;44;91;11;39;84;25;70;90;85;40;
Test 2 16;27;40;94;34;32;79;15;14;65;11;49;52;25; 72;80;90;1;6;68;100;76;93;98;3;74; 71;57;53;96;
Test 3 25;13;49;94;47;65;76;32;38;60;58; 74;55;71;53;56;50;30;98;24;82;1;89;26;41;88;21;67;86;85;

```

5.2 Validity of Scoring & Security

Score can be seen straight after a user has finished a CBT. The scores can also be monitored by the lecturers, so that users may complain if they see any discrepancies. A number of subjects such as Human Computer Interaction (CBT was carried out in 2003), Data Communications and Computer Lab. assistant screening test (2002-2004) have data banks for CBT. The total number of users who have used the two types of CBT (with MS Access and MS SQL connections) has exceeded 200. An example of a CBT score table for Data Communication is depicted in Table 1. Besides the three different users with different level of access with their corresponding individual password, the databases are protected by passwords as well. In the case of MS SQL, sa connection is not used in the program-code, rather a special user and password is created to facilitate the necessary connection and rights of access.

Table 1. CBT result for course subject: Data Communication

DataCom-UTS- Friday 19 March 2004			
No.	Name	Users' ID	CBTI
1	Michael Ernst Siwi	3520000067	70,0
2	Wasian Wowor	3520010085	66,7
3	Hendi Adelin	8220020003	71,7
4	Robin Wijaya	8220020005	58,3
5	Nurini Natania	8220020007	61,7
6	antonius	8220020009	56,7
7	Citara Nayla Iqbal	8220020015	60,0
8	Ricky Hendarsyah Hariadji	8220020017	38,3
9	alvin	8220020019	73,3
10	Robertus Dimas P	8220020027	63,3
11	Reza Soleman	8220020029	43,3
12	Susanti	8220020033	70,0
13	Marcos Picessalim	8220020035	60,0
14	Melly Anggraini	8220020039	71,7
15	Felix Maringka	8220020041	48,3
16	Eko Kurniawan	8220020043	50,0
17	Riawan	8220020045	61,7
18	Isabel	8220020051	70,0
19	Ronald Theo Jayadi	8220020059	66,7
20	Romauli Febrina Sinaga	8220020063	70,0
21	Shakti Candra S	8220020067	51,7
22	Ricky Tanaja	8220020071	66,7
23	ivana	8220020075	46,7
24	jimmy prawira	8220020079	61,7
25	suparli	8220020081	11,7
26	Berry Tanuwijaya	8220020083	63,3
27	alexander maxwell	8220020085	66,7
28	Frenco	8220020089	65,0

5.3 Monitoring and feedback features

Monitoring users – feature has been added in the CBT application with SQL connection – thus if any user performs an ungraceful exit after logging in, then this rough behaviour is recorded in a different log table. Besides this, Client IP (Internet Protocol) information, computer name are also saved in the log table. More over, if the lecturer wants to warn or advice any CBT users, he or she can easily send a message to that particular user. By typing a message, then choosing the row (with the desired name), and clicking on it. This event will invoke a message box to appear on the client – all of these features are made possible through the already available VB control called Winsock. Table 5.2 shows this capability. Notice that not all of the users are shown, to conserve space. It can be seen that computer 135-02 and 135-03, which are used by Susanti & Isabel have performed ungraceful-exits from the CBT application. While Antonius has used a computer which had its IP and name changed (not according to the original Lab. Set up). Also important to note that many of these tests were conducted during a busy day (more than 200 users were accessing the computer network) at the computer-lab.

Table 2. Monitoring users of Data Communications test (users are the same as in Table 1)

<i>No.</i>	<i>Name</i>	<i>Users' ID</i>	<i>Login</i>	<i>Logout</i>	<i>Client Name</i>	<i>Client IP</i>
1	Eko Kurniawan	8220020043	07:52:14	09:12:08	135-45	172.16.1.45
2	Romauli Febrina Sinaga	8220020063	15:56:22	17:18:24	135-21	172.16.1.14
3	Nurini Natania	8220020007	07:36:31	08:12:01	135-21	172.16.1.13
4	Ivana	8220020075	11:09:48	12:33:55	135-15	172.16.1.15
5	Citara Nayla Iqbal	8220020015	07:59:09	09:24:22	135-16	172.16.1.16
6	Hendi Adelin	8220020003	07:50:13	08:41:22	135-46	172.16.1.46
7	Frenco	8220020089	07:55:01	09:09:48	135-33	172.16.1.33
8	Melly Angraeni	8220020039	07:56:21	09:09:08	135-12	172.16.1.12
9	Robertus Dimas P	8220020027	07:53:31	08:45:09	135-21	172.16.1.182
10	Susanti	8220020033	07:58:11		135-02	172.16.1.2
11	Isabel	8220020051	07:54:32		135-03	172.16.1.3
12	Antonius	8220020009	07:58:14	08:52:54	81020057	4.212.68.153
13	Wasian Wowor	3520010085	07:55:51	09:14:26	135-37	172.16.1.37
14	Marcos Picessalim	8220020035	07:55:50	09:00:49	135-25	172.16.1.25
15	Alvin	8220020019	07:52:07	08:58:57	135-26	172.16.1.26

6. Conclusion & Suggestions

6.1 Conclusion

From this research, it can be concluded that:

- The RNG in VB has been applied successfully in the custom made CBT. Its randomness, the validity of its scoring have both been tested, and no resolvable problems have been found.
- More than 200 users have gone through the CBT and no resolvable problems have been found on the application and the network.
- RNG applied in VB requires unnoticeable delay time to CBT users, to produce random questions from a certain bank of questions; this statement has been true for 50 concurrent users.

6.2 Suggestions

Future work for this research includes:

- More investigation is required, in order to add graphical image displayer feature, both on the question and the multiple-choice possible answers. Multi-media features are also useful for subjects such as : English, and Medicine
- Additional fields have to be added, so that only one privileged user (problem creator) can access problems and answers of his/her responsibility.
- Socialization for the use of this CBT must be increased to attract other lecturers to make use of this facility.
- To support distant-learning, an internet version of this CBT, is also a viable alternative. The use of common internet browser, helps to avoid client application installation. However, appropriate security must be applied well. Perhaps, intranet use can be a good starting point.
- Another good feature to include is the ability to set the starting and ending question number, so that the random number is only generated from that range.
- To control the starting and ending time of the CBT, a lecturer should be able to create a flag on the database. This means when the lecturer wants to start or end a CBT, this control can be achieved easily.

6.3 Acknowledgements

It would be unfair if those who had helped in this research, are not mentioned. However, being forgetful, I would like to apologize first, particularly if I have forgotten any of you (believe me I did not mean to forget any of those who had helped). Much gratitude is expressed to students at Maranatha Christian University, such as Wirawan, Eko and Gunawan – they helped me in initial MS Access version of CBT for single user (for their help in data entry; for subjects: Digital Systems and Industrial Electronics, which I had taught I at that time), while at Universitas Pelita Harapan (UPH), Rusli (initial MS SQL version, single user test) and “Felix” Hadiyanto Asali (feedback modification). Also, sincere thanks to : the Vice Rector and Dean, Prof Dr. Muljono, Vice Dean Ir. Gunawan P. M.M, and the Head of the Department, Sutrisno M.Kom – all of them have helped in accepting this topic to be researched further, at UPH. Last but not least, other staffs such as : Petrus W. Dipl. Math, Budi S. M.Sc and I Made M. M.Kom – who have helped me with the introduction chapter in this research which has been included also in UPH’s research report.

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