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Implementation of the CLCG Method in the Implementation of Final Semester Exams

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Abstract

The final semester examination is one of the essential instruments in measuring students' competency achievement in schools. However, conventional exam implementation often faces challenges such as high operational costs, time-consuming correction processes, and the potential for cheating due to identical questions among students. This study aims to design and develop an Android-based examination application by implementing the Couple Linear Congruential Generator (CLCG) method as a question randomization mechanism. CLCG was chosen because it can generate random numbers with a more uniform distribution and longer period compared to the conventional Linear Congruential Generator (LCG), ensuring that each student receives a different set of questions while maintaining the same level of difficulty. The research was conducted at SMK Harapan Mekar 1 Medan using a prototype-based system development approach. The results show that the developed Android-based exam application runs effectively, successfully randomizes questions using the CLCG method, and facilitates teachers in managing the question bank and accelerating the grading process. Therefore, the application of the CLCG method in an Android-based digital exam system proves to improve efficiency, objectivity, and security in the implementation of final semester examinations in schools.

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1. Introduction

The development of technology and information in Indonesia is currently very complex and advanced, placing significant demands on those working in industry, companies, and education, particularly in the business sector (Arief Muhammad, 2021). Therefore, to produce a good and effective performance system, a company must provide excellent service. Human resources and other resources, such as information systems and information technology (Sonti Lena, 2020), are needed (Sonti Lena, 2020).

The development of information and communication technology in the current digital era has had a significant impact on education. The use of technology is not limited to learning activities but also includes evaluation systems such as exams. Exams are a crucial instrument for measuring

students' competency in understanding the material taught. However, in many schools, including SMK Harapan Mekar 1 Medan, the end-of-semester exam (UAS) system is still conducted conventionally using paper and pencil. This method is considered inefficient due to the high cost of duplicating questions, the risk of question leaks, and the time-consuming process of checking results.

Furthermore, another frequently occurring problem is the potential for student cheating on exams, especially when the questions are the same for each student. This reduces the objectivity of assessing individual student abilities. Therefore, a system is needed that can generate random, unique exam questions for each examinee, without compromising the teacher's predetermined difficulty level.

One method that can be used to generate random questions is the Couple Linear Congruential Generator (CLCG). CLCG is a random number generation method developed from the Linear Congruential Generator (LCG), but by combining two or more generators to produce better random numbers, with a longer period, and a more even distribution. By implementing this method, exam questions can be automatically arranged in a random order, thereby reducing the possibility of cheating among students.

In addition to the randomness aspect, the implementation of an exam system also needs to consider the media used by students. In the modern era, the majority of students are accustomed to using Android-based smartphones. Android was chosen because of its open source nature, flexibility, and its large user base among students. Thus, the development of an Android-based exam application will be more accessible and usable by students, and can facilitate schools in administering exams efficiently and effectively.

By incorporating the Couple Linear Congruential Generator (CLCG) method into the creation of Android-based exam questions, it is hoped that a fairer, safer, and more transparent exam system will be created. Teachers can easily manage question banks, while students can take exams more conveniently using their own devices. This aligns with the demands of developments in educational technology, which are driving the creation of modern, digital-based evaluation systems.

Based on this description, the implementation of the CLCG method in the Android-based final semester exams at SMK Harapan Mekar 1 Medan is expected to be a solution to overcome the limitations of conventional exam systems, increase exam efficiency, and provide more objective assessment results.

2. Research Methodolgy

The methods used by the author in designing, writing, and developing this thesis consist of several interrelated and complementary sections, namely:

1. Analysis and Design Method

The analysis and design method used in writing this thesis is the Object Oriented Analysis and Design (OOAD) approach using Unified Modeling Language (UML) notation, which includes flowcharts, use case diagrams, and screen designs.

2. Literature Review

The literature review process involves gathering the best and most accurate theoretical foundation possible by reading, studying, and searching for books, various scientific and general papers and discussion topics, and literature related to the topic being developed. The author sought various sources, both physical (attending in person, visiting libraries, bookstores, borrowing books from friends/lecturers, the author's personal collection) and online information searches (via the internet, discussion forums, articles supporting the author's research, various supporting e-books, etc.). In developing the system, the author uses the waterfall model or software life cycle, the software life cycle has the following stages:

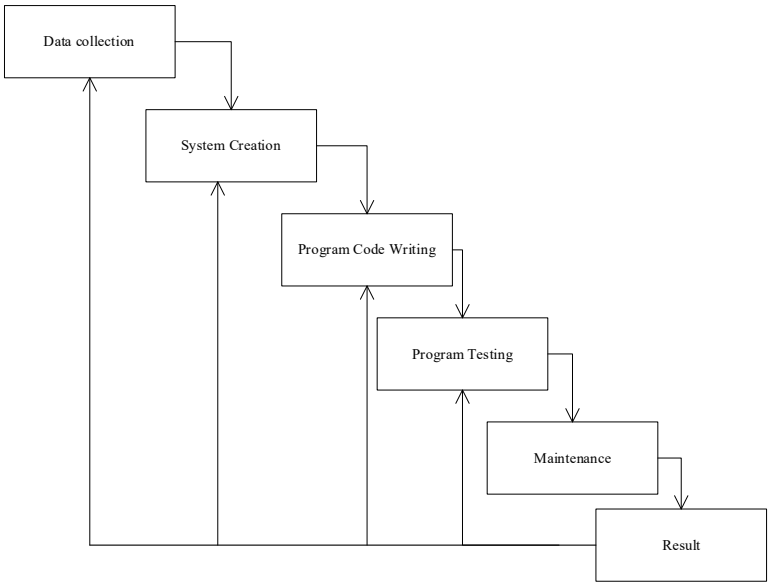


Figure 1. Waterfall Diagram

The development of the fishbone framework method involves several stages: requirements analysis, system design, coding, program testing, and system maintenance.

1. Research Target/Objective
   The target of this research is to determine the research object at SMK Harapan Mekar 1 Medan in the randomization of exam questions.
2. Needs Analysis
   Analyzing the existing system requirements and adding new systems to the design if necessary. The data required for this analysis are student data, grades, and exam data.
3. System Design
   This stage involves determining computer specifications, conducting interface design using Android Studio and MySQL, and designing the system using Unified Modeling Language (UML) modeling, including use case diagrams, class diagrams, activity diagrams, and sequence diagrams. The system design for the application uses Android-based programming. The requirements specifications for the system to be built are as follows:
   a. Hardware Specifications
   The required hardware specifications are:
   1) Intel Celeron CPU B815 1.60 GHz processor
   2) 4GB RAM
   3) 500GB hard drive
   b. Software Specifications
   The required software specifications are:
   1) Windows 8 operating system
   2) XAMPP-PHP-MySQL web server
4. System Coding
   Coding is the translation of a design into a language that can be recognized by a computer. This is performed by a programmer who will translate the transactions requested by the user. This stage is the actual stage in developing a system. In other words, computer usage will be maximized during this stage. After coding is complete, the system will be tested. The goal of testing is to identify errors in the system and then correct them.
4. Program Testing

This stage involves comprehensive application testing, including functional testing and system robustness testing. The testing performed is software testing, which tests the application's functionality against its internal structure or operation. Special knowledge of the application code/internal structure and programming knowledge is generally not required; testing is performed for each designed component.

5. System Maintenance
   Software that is difficult to deliver to customers will inevitably undergo changes. These changes may be due to errors, the software having to adapt to a new environment, or because the customer requires functional enhancements.

3. Results and Discussion

The flowchart of the CLCG method is as follows:

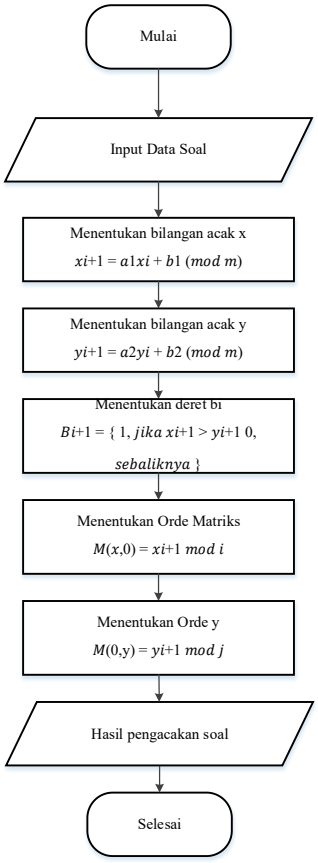


Figure 2. Flowchart of the CLCG Method

CLCG Method Case Study

The randomization pattern results are obtained by calculating the random results for each series using the CLCG method. The CLCG steps for randomizing school exam questions are:

1) Determine the number of questions to be randomized (m)
2) Determine the value of the multiplier variable (a)
3) Determine the additive variable (b)
4) Determine the number of rows and columns of matrix A, where the number of elements corresponds to the number of questions being randomized.

The following are the exam questions at SMK Tritech Medan:

LEMBAR SOAL

Mata Pelajaran	:	**PW & PERANGKAT BERGERAK**
Satuan Pendidikan	:	Sekolah Menengah Kejuruan
Bidang Keahlian	:	Bisnis dan Manajemen / RPL
Kelas/Kompetensi Keahlian	:	XII / RPL
Hari / Tanggal	:	Senin, 27 Maret 2023
W a k t u	:	10.00 – 11.00

PETUNJUK : 1. Tuliskan nomor **UJIAN** pada lembar jawaban yang disediakan.
2. Periksa dan bacalah soal dengan cermat sebelum mengerjakannya.
3. Berilah tanda silang (X) pada salah satu huruf a, b, c, d atau e sebagai jawaban yang paling benar

I. OBJEKTIF TEST

1. Halaman *web* yang dapat diakses dan berinteraksi sesuai dengan keinginan merupakan teknologi *web* yang berbasis....
   A. konten B. Struktural C. statis D. *Array* E. *dynamis*
2. Salah satu bagian pemrograman *web* yang pemrograman *web*nya ditentukan pada sisi *server* adalah ....
   A. Web programming client C. Database programming E. Database server
   B. Html programming D. Web server programming
3. Dalam desain web dikenal istilah hosting, yang mempunyai pengertian :
   A. Server yang harus kita miliki dalam jaringan internet.
   B. Alamat tujuan yang diketikkan pada address sebuah browser.
   C. Space/ruang yang kita tempati dalam sebuah server yang bias diakses.
   D. Alamat IP Address yang unik, tidak boleh duplikatnya.
   E. Program dan skrip yang merupakan penyusun halaman web.
4. Sedangkan Domain mempunyai pengertian yakni:
   A. Email yang harus kita miliki dalam jaringan internet.

B. Alamat tujuan yang diketikkan pada address sebuah browser berupa nama.

C. Space/ruang yang kita tempati dalam sebuah server yang bias diakses.

D. Alamat IP Address yang unik, tidak boleh duplikatnya.

E. Program dan skrip yang merupakan penyusun halaman web.

5. Sekelompok halaman web yang merupakan bagian dari suatu nama domain di www dalam internet disebut sebagai :

   A. Server B. Situs C. Address D. Browser E. Email

6. Secara garis besar, Joomla terdiri dari 3 elemen dasar yakni :

   A. DNS Server, PHP dan MySQL. C. Web Server, PHP dan MySQL. E. Proxi Server, PHP dan mySQL.

   B. Mail Server, PHP dan MySQL. D. DHCP Server, PHP dan mySQL.

7. Ada tersedia lebih dari 1.700 plugins yang secara resmi didelegasikan oleh opensourcematter yang bias diintegrasikan ke dalam joomla, alamat untuk mendapatkan fasilitas ini adalah :

   A. http://extensions.joomla.org C. http://modules.joomla.org E. http://installer.joomla.org

   B. http://plugin.joomla.org D. http://contens.joomla.org

8. Yang bukan Penyedia gratis hosting joomla dibawah ini adalah :

   A. 000webhost.com C. Extensions.Joomla.org B. Freejoomlas.com

   D. Joomlahostingfree.com E. Caboom.net

9. Dibawah ini penyedia domain gratis, yang bertujuan untuk memperpendek alamat yang panjang diantaranya :

   A. co.cc, dot.tk, co.nr C. co.id, co.cc, cc.cc E. co.cc, co.nr, co.id

   B. dot.tk, co.id, co.cc D. co.nr, co.id, co.cc

10. Untuk menuliskan URL pada Browser, anda dapat menuliskan pada bagian :

    A. Search B. Favorite C. Bookmark D. Cookies E. Address

11. Penulisan URL yang benar adalah…

    A. HTTP://www.000webhost.com C. HTTP//:freejoomlas.com E. HTTP:www.wordpresscom

    B. HTP//www.yahoo.com D. HTTP:www.blogger.com

12. Yang dapat dijadikan Hyperlink, kecuali ...

    A. Text / tulisan B. Gambar C. Tombol D. Image E. Browser

13. Sebuah komputer yang melayani permintaan halaman web adalah

    A. website B. situs C. webmaster D. web server E. web admin

14. Tag berikut yang menghasilkan tulisan paling besar adalah….

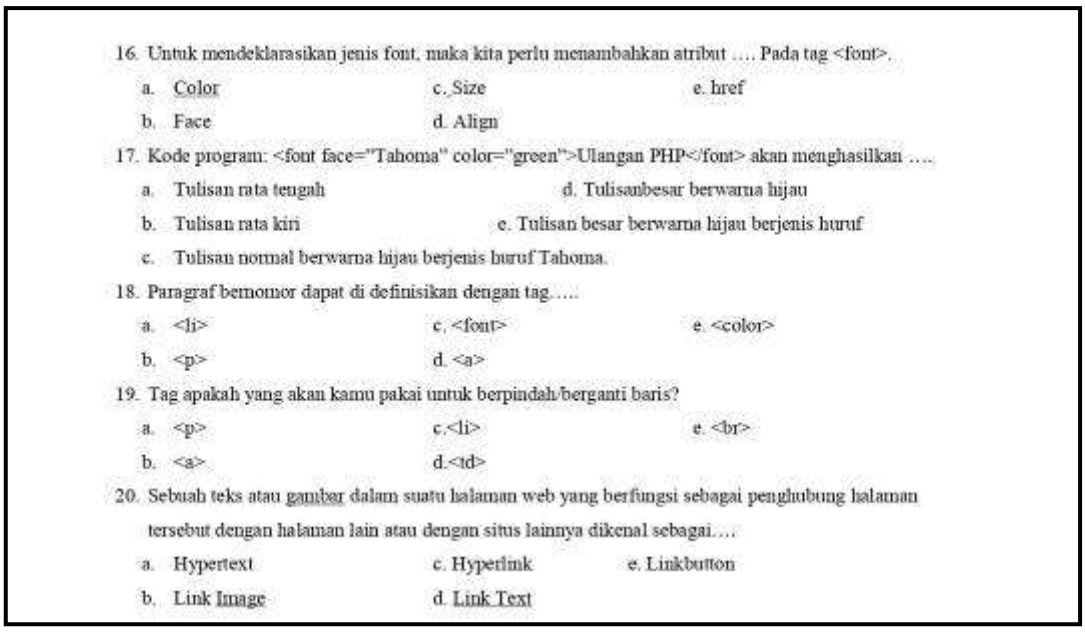
    a. <H6> c. <H2> e. <H7>

    b. <H5> d. <H1>

15. Tag yang mengatur pemformatan tulisan adalah….

    a. c. <body> e.

    b. <p> d.



16. Untuk mendeklarasikan jenis font, maka kita perlu menambahkan atribut .... Pada tag .
    a. Color c. Size e. href
    b. Face d. Align
17. Kode program: Ulangan PHP akan menghasilkan ....
    a. Tulisan rata tengah d. Tulisanbesar berwarna hijau
    b. Tulisan rata kiri e. Tulisan besar berwarna hijau berjenis huruf
    c. Tulisan normal berwarna hijau berjenis huruf Tahoma.
18. Paragraf bernomor dapat di definisikan dengan tag.....
    a. c. <font> e. <color>
    b. <p> d. <a>
19. Tag apakah yang akan kamu pakai untuk berpindah/berganti baris?
    a. <p> c. e.
    b. <a> d.<td>
20. Sebuah teks atau gambar dalam suatu halaman web yang berfungsi sebagai penghubung halaman tersebut dengan halaman lain atau dengan situs lainnya dikenal sebagai....
    a. Hypertext c. Hyperlink e. Linkbutton
    b. Link Image d. Link Text

Figure 3. Exam Questions at SMK Harapan Mekar 1 Medan

The grades for each stage are determined as shown in Table III.1.

Table 1: Variable Values for Each Stage

No	Number of Questions (m)	a	b	Mx	my
1	20	21	17	4	5

To assign values to matrix elements, the LCG method is used as in Table 2.
((21 * 12) + 17) mod 20 = 9
((21 * 9) + 17) mod 20 = 6
((21 * 6) + 17) mod 20 = 3
((21 * 3) + 17) mod 20 = 20
((21 * 20) + 17) mod 20 = 17
((21 * 17) + 17) mod 20 = 14
((21 * 14) + 17) mod 20 = 11
((21 * 11) + 17) mod 20 = 8
((21 * 8) + 17) mod 20 = 5
((21 * 5) + 17) mod 20 = 2
((21 * 2) + 17) mod 20 = 19
((21 * 19) + 17) mod 20 = 16
((21 * 16) + 17) mod 20 = 13
((21 * 13) + 17) mod 20 = 10
((21 * 10) + 17) mod 20 = 7
((21 * 7) + 17) mod 20 = 4
((21 * 4) + 17) mod 20 = 1
((21 * 1) + 17) mod 20 = 18
((21 * 18) + 17) mod 20 = 15
((21 * 15) + 17) mod 20 = 12

The values of the matrix addresses generated using the CLCG method.

9	6	3	20
17	14	11	8
5	2	19	16
13	10	7	4
1	18	15	12

Calculation of random numbers and according to equation (3) in table 3 and equation (4) in table III.4.
Result (x)
((21 * 3) + 17) mod 5 = 5
((21 * 0) + 17) mod 5 = 2
((21 * 2) + 17) mod 5 = 4
((21 * 4) + 17) mod 5 = 1
((21 * 1) + 17) mod 5 = 3
((21 * 3) + 17) mod 5 = 5
((21 * 0) + 17) mod 5 = 2
((21 * 2) + 17) mod 5 = 4
((21 * 4) + 17) mod 5 = 1
((21 * 1) + 17) mod 5 = 3
((21 * 3) + 17) mod 5 = 5
((21 * 0) + 17) mod 5 = 2
((21 * 2) + 17) mod 5 = 4
((21 * 4) + 17) mod 5 = 1
((21 * 1) + 17) mod 5 = 3
((21 * 3) + 17) mod 5 = 5
((21 * 0) + 17) mod 5 = 2
((21 * 2) + 17) mod 5 = 4
((21 * 4) + 17) mod 5 = 1
((21 * 1) + 17) mod 5 = 3

Result (y)
((21 * 4) + 17) % 4 = 1
((21 * 1) + 17) % 4 = 2
((21 * 2) + 17) % 4 = 3
((21 * 3) + 17) % 4 = 4
((21 * 0) + 17) % 4 = 1
((21 * 1) + 17) % 4 = 2
((21 * 2) + 17) % 4 = 3
((21 * 3) + 17) % 4 = 4
((21 * 0) + 17) % 4 = 1
((21 * 1) + 17) % 4 = 2
((21 * 2) + 17) % 4 = 3
((21 * 3) + 17) % 4 = 4
((21 * 0) + 17) % 4 = 1
((21 * 1) + 17) % 4 = 2
((21 * 2) + 17) % 4 = 3
((21 * 3) + 17) % 4 = 4
((21 * 0) + 17) % 4 = 1
((21 * 1) + 17) % 4 = 2
((21 * 2) + 17) % 4 = 3
((21 * 3) + 17) % 4 = 4

After the calculation is complete, the address and value of the randomized question are obtained, as shown in Table III.6.
Random Result (x, y)
Urutan 1 [5, 1] = 1
Urutan 2 [2, 2] = 14
Urutan 3 [4, 3] = 7
Urutan 4 [1, 4] = 20
Urutan 5 [3, 1] = 5
Urutan 6 [5, 2] = 18
Urutan 7 [2, 3] = 11
Urutan 8 [4, 4] = 4
Urutan 9 [1, 1] = 9
Urutan 10 [3, 2] = 2
Urutan 11 [5, 3] = 15
Urutan 12 [2, 4] = 8
Urutan 13 [4, 1] = 13
Urutan 14 [1, 2] = 6
Urutan 15 [3, 3] = 19
Urutan 16 [5, 4] = 12
Urutan 17 [2, 1] = 17
Urutan 18 [4, 2] = 10
Urutan 19 [1, 3] = 3
Urutan 20 [3, 4] = 16

Based on Table III.5, the results of the CLCG application can be seen in the form of random numbers obtained from the values of the matrix elements according to the addresses generated from the applied equation. Thus, the results of the randomization of the questions can be obtained as follows:

No	Number of Questions	Randomization Results
1	20	1,14,7,20,518,11,4,9,2,15,8,13,6,19,1217,10,3,16

4. Conclusion

From the results of the author's research on the Application of the Couple Linear Congruential Generator (CLCG) Method in the Final Semester Exam at SMK Harapan Mekar 1 Medan Based on Android, several conclusions can be drawn, including the System that has been built can help overcome obstacles in carrying out the Exam process at SMK Harapan Mekar 1 Medan, the exam process is carried out with random questions between students then students can see the value of the subjects being tested. By building an Online exam implementation application at SMK Harapan Mekar 1 Medan using the Android-based CLCG method, it will help the exam implementation process and determine the answer values from student exams, and students can see the exam scores for each subject. The application is designed using the Android Studio application and the Mysql database.

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