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Information System Web Based for Group Randomization of State Defense Education Class using Linear Congruential Method

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ABSTRACT

One of the actual forms of state defense education is through outbound activities. In this context, education is interpreted as a process to humanize humans to become fully human adults. However, the world was shocked by the outbreak of a disease caused by a virus called corona or known as covid-19. Transmission through social contact between humans is difficult to predict and also cannot be avoided so its spread is also very rapid. Therefore, it is necessary to change the outbound state defense education method from conventional activities to offline activities based on the web and automatically computed. The system will replace the conventional process of supervising outbound activities where activities that are usually carried out in groups and simultaneously, will be carried out independently by sending evidence of activities that have been recorded through document files or videos. The results of this study are the Outbound State Defense Group Randomization Information System (SIOBEL) using the Linear Congruent Method (LCM) which helps in creating random groups of students and with the Graph Query Language (Graph-QL) system architecture which can facilitate interface and system developers to exchange data.

Keywords: Information system, Graph-QL, linear congruent method, outbound state defense

Introduction

National defense education is one of the actual manners to defend the country against non-military threats. The real activities of defending the country are carried out at universities which are expected to create the character of the younger generation. Through education, defending the country can build mindsets, values, and norms in society (Rohma et al., 2020). However, the world was shocked by the outbreak of a disease caused by coronavirus disease 19. Hundreds of thousands of people are exposed to this virus worldwide, even causing tens of thousands of people to die. Transmission through social contact between humans is difficult to predict and also cannot be avoided so its spread is also very rapid. The antidote has not yet been found to be the cause of many deaths. The complexity of handling this outbreak has made world leaders and including Indonesia make super tight policies to break the chain of the spread of COVID-19, namely by implementing social distancing (restrictions on social interaction) (Komalasari et al., 2020).

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The coronavirus disease 19 pandemics has forced many organizations to undergo significant transformations, re-examining key elements of their business processes and using technology to maintain operations while staying abreast of changing new guidelines and procedures. This study offers collective insight into many of the key issues and forms affecting organizations and society from COVID-19, through an information system and technology perspective. The views of the 12 invited subject experts were collected and analyzed where each compiles their perspective relating to online learning, digital strategy, artificial intelligence, information management, social interaction, cybersecurity, big data, blockchain, privacy, mobile technology, and strategy through the lens of the current crisis and these specialized areas. Expert perspectives provide timely insights on a wide range of topics, Identify key issues and recommendations for theory and practice (Dwivedi et al., 2020).

Information technology is currently very developed in various fields of life such as health, security, economy, and education. In practice, most universities, both public and private, have implemented information systems in various forms and functions, from simple to very high levels of complexity. Information systems in the field of education are an association of people, software, hardware, procedures, and rules that work together and are integrated to achieve the effectiveness of the educational process (Satyahadewi, 2019).

In the previous research, the author refers to previous research from a journal entitled Designing a Web-Based Student Task Collection Management Information System (SIMPEGASMA). In his research, he explained the task management information system needed by Citra Bangsa University. The required system requires assignment, assignment collection, and assignment checking. In the journal, the problem that arises from the analysis carried out is the difficulty in managing the number of tasks manually so that it is less organized. Task monitoring also becomes difficult due to the disorganized state of the task. So that the solution is to design a Task Collection Management Information System using a Web base (Imanuel, 2019). Another study entitled An Initial Analysis of Facebook's GraphQL Language describes the use of GraphQL as a means of Application Programming Interface (API) resulting in a smaller data output size because when compared to other APIs that display all data and sub-data, GraphQL will only display data specified object. For this reason, GraphQL has become the API architecture of choice for the system in this research (Hartig & Perez, 2017).

Furthermore, in the research entitled Application Design With Linear Congruent Method (LCM) as a Randomization Question. In this study, Muhammad Ganda Arizqia explained that the implementation of the exam needed to pay attention to acts of cheating because, in the process, the questions obtained by participants were the same. The solution given is the application of different types of questions to minimize fraud. The solution is to apply randomization of questions to the exam application using the LCM method. LCM can minimize fraud in a certain group, this is the reason for choosing an auxiliary algorithm in making the system in this study (Arizqia & Widodo, 2017a). Based on previous research that has described the data, it can be concluded that the SIOBEL API design research will use the GraphQL architecture which has a smaller data return size with an LCM supporting algorithm that can be a random function in class members. Making this API can then be developed as a means of integrating data from several platforms.

The important aspect of education, the quality of education must also be considered. The implementation of computerized exams needs to pay attention to possible fraudulent acts (Arizqia & Widodo, 2017b). This could be due to the cooperation of several parties who know each other. With this possibility, randomization of the participant group, as well as the assessor, becomes something that needs to be applied. The implementation of randomization was made using the Pseudo-Random Number Generator (PRNG) method. The use of the PRNG method can generate random numbers through a cryptographic algorithm with a generator source from the variables used in the algorithm. The algorithm Linear Congruential Method (LCM) is one of the algorithms using the PRNG method. Determination of constants in LCM greatly determines whether or not the random numbers obtained are obtained in the sense of obtaining random numbers as if there

is no repetition (Hangga & Prabowo, 2016). Based on this introduction, the authors conducted research on the design and development of the topic into group randomization analysis using Linear Congruential Method (LCM) for the classification of the student.

Material and Methods

Outbound

Outbound is training for self-development within the team. Outbound is a training method for personal and team development in the process of seeking experience through outdoor activities. Outbound is one of the learning methods through experiential learning. The form of the activity is the application of light games, each game in outbound activities has a deep, philosophical meaning and is full of useful symbolic messages and builds character towards success in life, both success at the level of individual and team/group success (Buchori et al., 2016)

State Defense

State defense is the attitude and actions of citizens based on love for the homeland, awareness of the nation and state, belief in Pancasila as the ideology of the nation and state, willingness to sacrifice to face every threat, challenge, obstacle, and disturbance both from within and from outside that endangers the survival of the nation and state, territorial integrity, national jurisdiction and the noble values of Pancasila and the 1945 Constitution. This understanding provides the widest opportunity for every citizen to carry out state defense activities (Widodo, 2011). The values contained in defending the country are loving our motherland, awareness of the nation and state, being convinced of Pancasila as the state ideology, being willing to sacrifice for the nation and state, and having physical and psychological readiness.

Information System

Information systems are information technology and people's activities that are combined to support operations and management. The term information system is broader, which refers to the interaction between people, algorithms, data, and technology. Thus, the information system means the relationship of data systems with the activities of people who communicate with each other representing the process of forming social memory, where information systems can also be considered as semi-formal materials in supporting humans to facilitate decision-making and action (Agus, 2011).

Information System according to Sutabri (2012), Information System is a system within an organization that brings together the daily transaction processing needs that support the organizational operational functions that are managerial with the strategic activities of an organization to be able to provide certain outside parties with reports that needed. The components of the information system are as follows:

1. Input Block
   Input represents data that enters the information system. The intended input is the method and media to capture the data to be entered, which can be in the form of large documents.
2. Block model
   This block consists of a combination of procedures, logic, and mathematical models that manipulate input data and data stored in the database in a certain way to produce the desired output.
3. Output Block
   The product of the information system is the output which is quality information and useful documentation for all levels of management and all system users.
4. Technology Bloc
   Used to receive input data, store and access data, generate and send output from the system as a whole. The technology consists of three main parts, namely; users (brainware), software (software), and hardware (hardware).

5. Database Block
   A collection of related data, stored on computer hardware and used by software to manipulate it and generate information.

Framework Laravel

Laravel is an MVC web development framework designed to improve software quality by reducing development and repair costs and increasing work productivity with a clean and functional syntax that can reduce a lot of time for implementation (Luthfi, 2017). The Laravel framework features include:

1. Resource Controller
   Resource Controller is a feature used to drive the creation of controllers. the request logic on the server includes the logic in HTTP handling.
2. Central Device
   Middleware is a feature that provides a mechanism to filter HTTP requests before they are forwarded to the controller that goes to the application.
3. Fluent ORM
   Eloquent ORM is an implementation of ActiveRecord that is used to manage relationships between tables in the database. In Eloquent ORM the table is represented in the form of a class and the data stored in the table is represented in the form of an object.
4. Migration
   Migration is a feature in laravel, migration is a Control Version System for databases. Migration is saved in a PHP file format which can be called with certain command-line functions.

Application programming interface

An API is used to expose services or data provided by a software application through a predefined set of resources, such as methods or objects. Using these resources, other applications can access data or services without having to implement the underlying objects and procedures. APIs are essential to many modern software architectures, as they provide high-level abstractions that facilitate programming tasks, support the design of distributed and modular software applications, and code reuse (Meng, 2018).

Graph Query Language (GraphQ)

GraphQL is a new concept in building APIs. GraphQL provides a complete and understandable description of the data in your API, gives clients the ability to ask what they need and nothing more, makes it easier to develop APIs over time, and enables powerful developer tools. by Facebook and implemented on the server-side. Although it is a query language, GraphQL is not directly linked to the database. In other words, GraphQL is not tied to any database. GraphQL that uses a single endpoint is more efficient than other APIs that use multiple endpoints, but GraphQL will also be a bit slower to query complex databases and have many relationships in addition to that other APIs are built with multiple endpoints to determine the data returned. This will increase the number of client-server calls to display data to the user and this may result in poorer service performance in Application requirements (Hartina et al., 2018).

Linear Congruent Method (LCM)

LCM is a random number generator widely used in computer programs. The LCM method uses a linear recursive algorithm combined with a modulus function. LCM determines whether or not a random number is obtained in the sense of obtaining a random number - there will be no damage. LCM utilizes a linear method to generate a random number which is defined as follows:

$$X_{n+1} = (a\ X_n + c)\ mod\ m$$

X_{n+1} : Random Value
X_n : Random Value to-n
a : Multiplier Factor
c : Increment
m : Modulus

The conditions for determining the constants in LCM are as follows:

1. c is prime relative to m
2. For the constant c, it must be an odd number if m is a power of two. Cannot be a multiple of m
3. The constant a must be greater than m
4. For the first X_0 must be an integer number and also odd is large enough

Black-box testing

Black-box testing, as one type of functional testing, is testing without knowing the interior structure of the application. The tester will interact with the system's user interface by providing input and checking the output without knowing how and where the input is performed. (Xu et al., 2016).

The main focus of black-box testing is the availability of inputs for the application and the expected outputs for each input value. This testing method is based on software requirements and specifications. Black-box is a testing technique where the parts of the system being tested are unknown, it is also called specification-based testing and behavior testing. This technique is so named because, in this test, the tester does not need to know about the implementation of the application's internal code. This test handles valid and invalid input according to system requirements (Verma et al., 2017).

Material and Methods

The procedure for making and designing this system uses the waterfall SDLC (System Development Life Cycle) method which has an important place in software engineering. The waterfall paradigm is the most widely used and oldest software engineering paradigm. There are 4 stages in this research process, namely preliminary study and analysis, design, implementation, and testing.

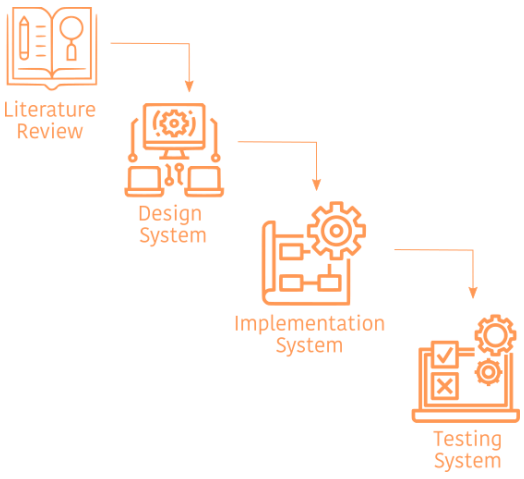

Figure 1. Research method flow

The stages of the waterfall method in Figure 1.1 development theory where the first is a preliminary study and analysis which is realized by collecting data from the Learning Development and Quality Assurance Institute (LP3M) at the National Development University "Veteran" East Java and a literature study is carried out to obtain theories supporters in this study

such as the design of the Outbound State Defense Information System (SIOBEL) and Graph-QL application. The design is carried out to adjust the model on the system with the criteria given at the analysis stage. Implementation and testing are the realizations of what has been designed in the previous stage.

Business Process Analysis

From the results of interviews conducted with LP3M, several needs for the use of the API to be built were made, namely:

1. Outbound State Defense participants can upload files in the form of videos, images, or documents.
2. Admin can add, change, and delete users including lecturers and students
3. Admin can determine the end date of the participant's assignment collection and the end date of the lecturer's assessment
4. Admin can add, change, and delete student or lecturer data from class
5. Each rubric point has several indicators and each indicator has activities that are assigned tasks
6. Participant's final scores can only come out if the scores have been locked
7. The locked value cannot be changed again except with admin approval.
8. Lecturers can only lock participants' scores if only all mandatory assignments have been uploaded and assigned grades, exceptions for admins can unconditionally lock overall grades.
9. The Participant assignments that are not uploaded will not be scored.
10. The system can provide a recap of grades in the form of excel per class, or overall.

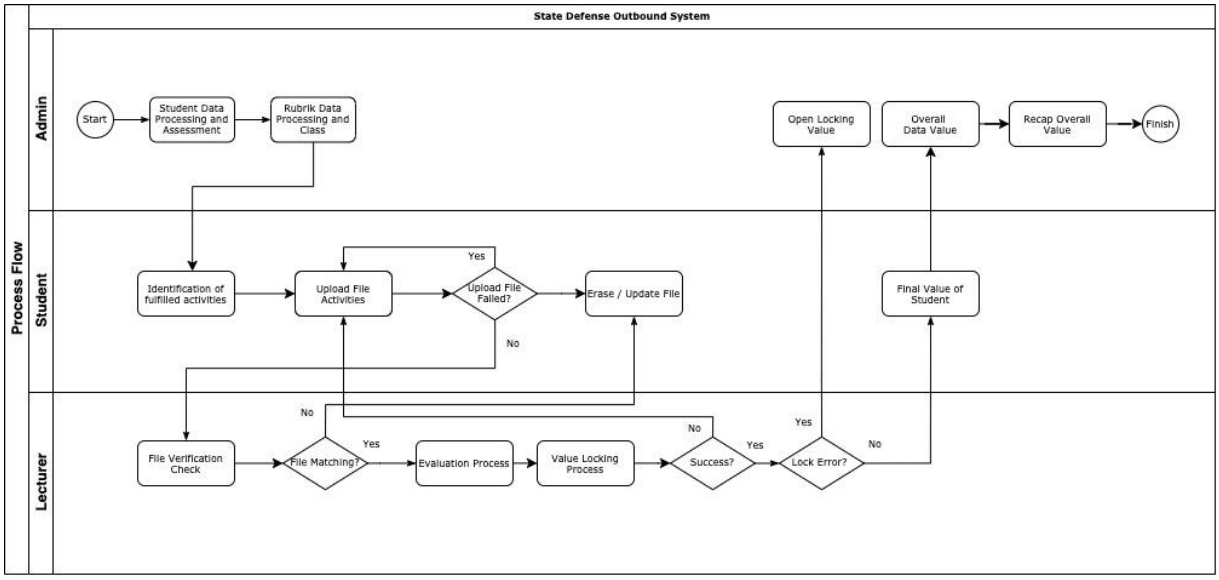

Figure 2. Business process flow

System architecture

The State Defense Outbound Information System Backend Architecture uses the Laravel framework with the Lighthouse library. Laravel framework is used to process data that will be received and issued by the server which will be forwarded on the client-side. And the lighthouse library is used to manage the architecture between the Graph-QL API and the PHP language.

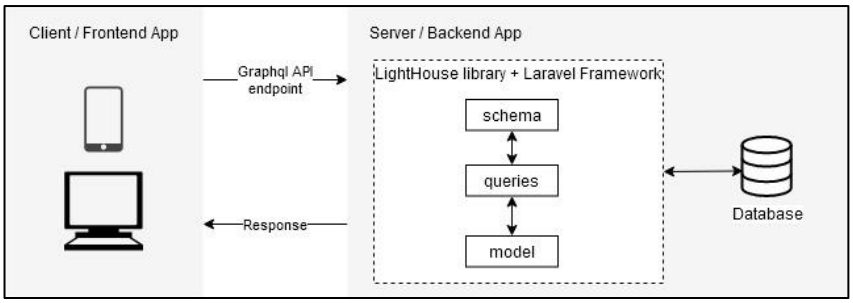

Figure 3. Design architecture systems

In Figure 3 it can be seen that after the data is received from the client via the Graph-QL endpoint, the schema will check whether the query and mutation are available on the server. On the server side, it will receive and check the Graph-QL Schema whether the query or mutation is available on the server. If available, it will be checked on the Middleware used in the query or mutation in the Graph-QL Schema to check access rights and authentication of users who are logged on to the system. Middleware is an intermediary between requests that come from the client with the intended function. If the Middleware check result has been successful, then proceed to the Graph-QL Resolver.

Database Design

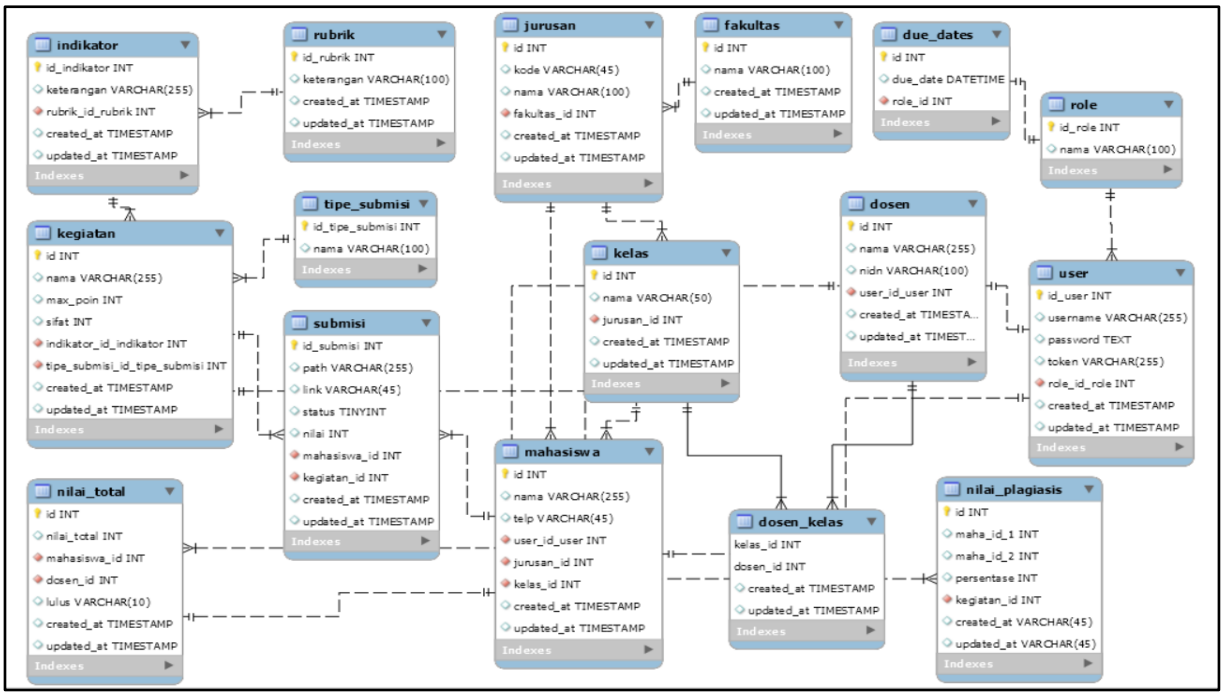

Figure 4. Design database table

In designing the database in this study, the structure used is to accommodate all existing data in the system process from entering the system to the end of the outbound defense assessment process. Figure 3 shows all the database structure entities used in the Outbound State Defense Information System. The picture shows all entities including one of them, namely the role entity that is used to authenticate each user entity in the system, where the role regulates the access rights owned by students, lecturers, and admins.

In the process of implementing the database structure to the Management Database, The system (DBMS) will use the migration features provided by Laravel. From several entity structures that exist in the image, there is an id attribute, created_at and updated_at are the results of migrations in Lumen. Meanwhile, to manage relationships between entities, we will use the model class features that exist in Lumen.

Graph-QL design

The Graph-QL schema is the core of the Graph-QL server implementation. This schema describes the functionality available to client applications that connect to the server. Graph-QL schemas can be created in any programming language and build interfaces within them.

The Graph-QL process defines a generic graph-based schema to publish its data service capabilities. Client applications can make requests to the server freely. This approach separates the client from the server and allows both to develop and develop independently. In the Graph-QL schema, there are 3 basic types, namely object type, mutation, and query.

Linear congruent method algorithm design

The algorithm applied in this information system is the LCM algorithm. This algorithm is used to perform linear randomization of an object. In the case of this system, the LCM algorithm is used in randomizing groups or classes of students into several sections in each faculty. Randomization was done randomly without looking at the study program of the students and divided equally among all faculties. One example is in one faculty, if the faculty takes 4 classes or groups, the algorithm will give the groups that have been randomized to the faculty.

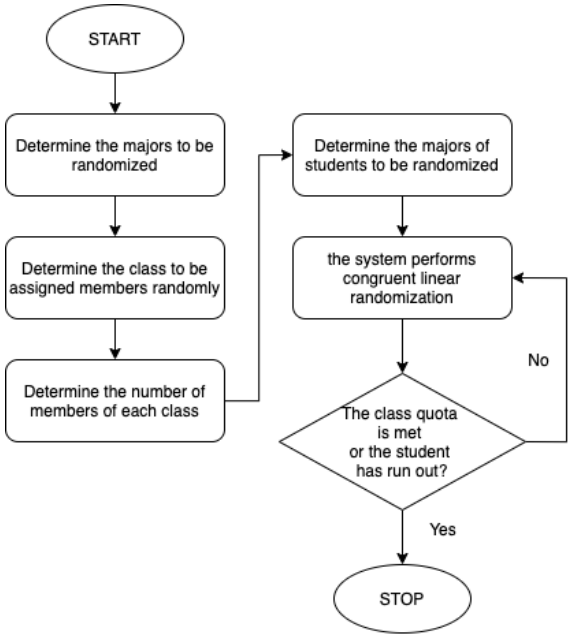

Figure 5. Linear congruent algorithm flow

Figure 5 is the flow of the LCM algorithm which is used as one of the features in this system to determine random class members. Before the system performs the randomization process, it must first select a class to be assigned a random student along with the maximum number of class members. Followed by taking students from certain majors which will be distributed to randomly selected classes. The process will be completed if the quota of the specified class has been met or the selected student has run out.

The LCM algorithm has a constant variable that greatly determines the output flow of a random number series. From the terms and conditions applied to the LCM constant, several values that meet the requirements are obtained which are shown in Table 1.

Table 1. A parameter value of the linear congruent method

No	Student Capacity	Parameter		
		a	c	m
1	50	31	19	53
2	40	35	13	41
3	20	44	37	23
4	30	55	41	31
5	35	59	71	37

The maximum parameter of the optimal member indicates the value that, if used, will produce a series of random numbers that will not repeat itself. Likewise with a mod which is the modulus that must be a prime number, in the example showing the value of a prime number is close to the maximum value of the member. Parameters a and b are multiplier and adder values in the algorithm which can be independent but still follow changes in the modulus value.

$$X_{n+1} = (a\ X_n + c)\ mod\ m$$

An example of the calculation value using the LCM formula with optimal parameters, with starting X_n from 1 is shown in Table 2.

Table 2. Calculation of parameter value linear congruent method

No	Parameter1	Parameter2	Parameter3	Parameter4	Parameter5
1	50	7	12	3	19
2	32	12	13	20	8
3	4	23	11	25	25
4	37	39	15	21	29
5	0	25	7	18	6
6	19	27	0	8	18
7	25	15	14	16	23
8	52	5	9	22	22
9	41	24	19	11	0
10	18	33	22	26	34
11	47	20	16	14	5
12	45	16	5	5	33
13	36	40	4	6	20
14	22	19	6	30	30
15	12	22	2	17	28

Testing design

System testing is used to find out all the features of this information system are running as expected. From the design that has been made, the system test will test every function that exists in Mutation and Query Grahp-QL Schema. The type of testing used is black-box, namely testing based on system functionality using system testing.

The correctness of the software is tested based on the functions and outputs generated from the data/input conditions given without seeing how the process is to get the output. In this test,

the Altair application will be carried out on each Mutation and Graph-QL Schema Query directly from the API system access point created.

Results and Discussion

Linear congruent method algorithm implementation

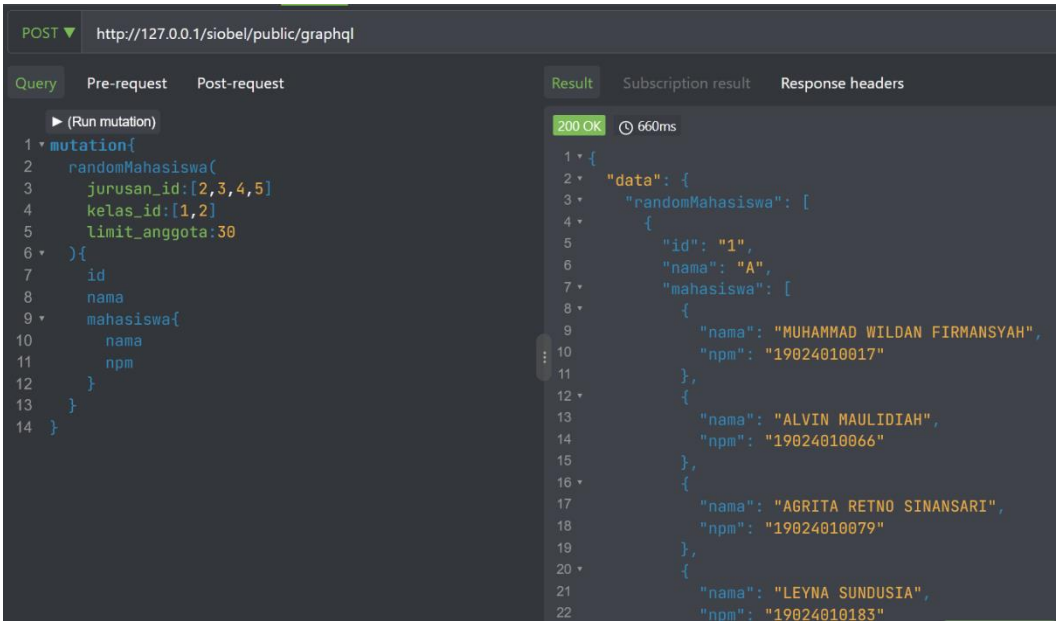

Figure 6. Implementation of mutation in LCM algorithm

Figure 6 is a mutation that uses the LCM algorithm and is used to fill in class data with random students. The required parameter is the department that contains the id of the student major selected as a class member candidate. *Class_id* is used for any class data that students will randomly assign. *Limit_member* is sent as the maximum number of members of the class that will be assigned members at random. The system then returns the scrambled class and member data.

The process starts by retrieving the required parameter data, namely class arrays, majors arrays, and class limit values. With several classes that can be selected directly, looping is carried out as many as the number of classes selected. Data retrieval of students with the chosen major is also carried out in a loop so that every time the program is repeated to the next class, student data will also be retrieved again to update the data of students who do not have classes.

Furthermore, the number of student data obtained is calculated as a consideration in determining the modulus. Before stepping into the use of algorithms, if the data of students who have not had a class is less than the maximum number of class members specified, all student data will be entered into the class. In the use of the algorithm, the modulus that will be used is determined in advance by taking the amount of student data obtained and determining the value of the nearest existing prime number. Followed by the determination of the seed or the first random number taken at random with a value range of 1 to the modulus value. The constants a and b as multipliers and additions have been determined based on the conditions to achieve the optimal number series that has been described in the previous chapter. Then iterate over the LCM series calculations using the variables that have been obtained as many as the specified number of class members. If the results of the number series obtained are not optimal, the calculation will be repeated until the optimal series of values is obtained. The optimal number series obtained is then used as a random index on the selected student candidates and changes in class members are stored in the database. The system then returns class data along with random students that have been added.

Graph-QL Testing

Based on the trial scheme in the previous chapter. Tests were carried out on each section of the Graph-QL API. The results of the Graph-QL test are based on the results of the implementation that has been carried out. From the implementation of the API, the results of the implementation are tested for each part of the API. The test results of each section can be seen in Table 3.

Table 3. Testing results graph-QL

No	Testing Scenario	Test Case	Expected Results	Testing Results
1	Entry into Systems	Create email and password correctly	Returns True	Expected
		Create email and password incorrectly	Returns False	Expected
		Empty email and password	Returns False	Expected
2	Request Reset Password	Filling Data Correctly	Returns email to Admin and Returns True	Expected
		Fill in Data Incorrectly	Returns Error Message	Expected
⋮	⋮	⋮	⋮	⋮
50	Due Date	Perform a *due_date* query with id role	The system sends *due_date* data according to the role	Expected
51	Due Dates	Perform a *due_dates*	The system sends *due_date* data according to dates	Expected

If the Graph-QL test on each function has been carried out, then it is continued with the validation test. The validation test will be carried out by 2 users using the black-box method where the test results will be by the information in Table 3 and if the results do not match, then the results can be caused by network errors, user input, or on the server. The test is carried out on a scale of 1 and 2 where 1 means appropriate and 2 means not appropriate. The results of the tests carried out can be seen in Table 4.

Table 5. Testing results by 2 users

No	Function Test of Graph-QL	User1	User2	No	Function Test of Graph-QL	User1	User2
1	login	1	1	42	randomMahasiswa	2	1
2	resetPassword	1	1	43	addKegiatan	1	1
3	updateUserPassword	1	1	44	updateKegiatan	1	1
4	updateUser	1	1	45	deleteKegiatan	1	1
5	addTipeSubmisi	1	1	46	addJurusan	1	1
6	updateTipeSubmisi	1	1	47	updateJurusan	1	1
7	deleteTipeSubmisi	1	1	48	deleteJurusan	1	1
8	addSubmisi	1	1	49	addIndikator	1	1
9	updateSubmisi	1	1	50	updateIndikator	1	1

To be continued…

No	Function Test of Graph-QL	User1	User2	No	Function Test of Graph-QL	User1	User2
10	deleteSubmisi	1	1	51	deleteIndikator	1	1
11	txtConvert	2	1	52	addFakultas	1	1
12	getTextPDF	2	1	53	updateFakultas	1	1
13	updateNilai	1	1	54	deleteFakultas	1	1
14	kunciNilai	1	2	55	addDosen	1	1
15	kunciKelas	1	2	56	updateDosen	1	1
16	addRubrik	1	1	57	deleteDosen	1	1
17	updateRubrik	1	1	58	addDosenToKelas	1	1
18	deleteRubrik	1	1	59	deleteDosen-FromKelas	1	1
19	kunciKeseluruhan	1	2	60	updateDueDate	1	1
20	deleteNilaiTotal	1	1	61	plagiasi	1	1
21	addMahasiswa	1	1	62	addMahasiswaTo-Kelas	1	2
22	updateMahasiswa	1	1	63	deleteMaha-siswaFromKelas	1	1
23	deleteMahasiswa	1	1	64	updateKelas	1	1
24	addKelas	1	1	65	deleteKelas	1	1
25	user	1	1	66	kelas	1	1
26	users	1	1	67	kelass	1	1
27	me	1	1	68	kegiatan	1	1
28	role	1	1	69	kegiatans	1	1
29	roles	1	1	70	jurusan	1	1
30	dosen	1	1	71	jurusans	1	1
31	dosens	1	1	72	fakultas	1	1
32	mahasiswa	1	1	73	fakultass	1	1
33	mahasiswas	1	1	74	rubrik	1	1
34	submisi	1	1	75	rubriks	1	1
35	submisis	1	1	76	indikator	1	1
36	tipe_submisi	1	1	77	indikators	1	1
37	tipe_submisis	1	1	78	due_date	1	1
38	nilai_total	1	1	79	due_dates	1	1
39	nilai_totals	1	1				
40	dosen_kelas	1	1				
41	dosen_kelass	1	1				

From the data in Table 5, the Kappa Cohen test calculation will be carried out using the SPSS application. The results of these calculations are:

Table 6. Calculation results using Kappa Cohen

Symmetric Measures					
		Value	Asymptotic Standard Error	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	0.738	0.177	6.794	0.000
N of Valid Cases		79			

Based on the Kappa Cohen value obtained in Table 46, which is 0.738, it shows that the level of test similarity between examiner 1 and examiner 2 is sufficient or moderate. Hence it can be concluded that there are sufficient similarities in the Graph-QL function test conducted by user1 and user2.

Conclusion

This research has completed the design and development of the Outbound State Defense Group Randomization Information System Using the Linear Congruent Method. Where this system can replace conventional outbound activities which are expected by students and lecturers to be facilitated by directed design so that the outbound process of students can run regularly without being hindered by circumstances. In the process of making the system, the analysis is carried out by conducting interviews with LP3M institutions related to outbound activities which will later be described as case studies to make the business process of the system to be built.

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