Exploremetics
Journal of Innovative
Engineering and Technology

Volume: 05 No: 02 | August -2024
ISSN (Online) 2636 – 590
ISSN (Print) 2636 - 591X

ADVANCEMENTS IN E-LEARNING: DESIGN AND IMPLEMENTATION OF A VIRTUAL CLASSROOM AND TEXT-BASED ENVIRONMENT

Edemejaro Kesiena[*1], Nwobodo-Nzeribe Harmony[1], Chibueze Kingsley [1]
1 Department of Computer Engineering, Enugu State University of Science and Technology
Author for correspondence: Edemejaro Kesiena; Email: edemejarokings@gmail.com

Abstract - This paper delves into the design and implementation of a virtual classroom and text-based e-learning environment, aiming to address the challenges faced by the Nigerian educational landscape, particularly the dearth of physical facilities. Through a hybrid approach of synchronous and asynchronous e-learning techniques, this study endeavors to foster collaborative and didactic learning experiences while providing a platform for comprehensive feedback mechanisms. Drawing from existing literature, various e-learning models are analyzed to devise a tailored solution that combines cost-effective delivery, interactive features, and round-the-clock accessibility. Methodologically, the study employs a comprehensive approach integrating design and implementation aspects, utilizing tools and programming languages such as HTML, Visual Basic, and FrontPage Express. The resulting system encompasses multiple modules, including input forms for data entry, output specifications for relevant information dissemination, and procedural charts for user guidance. Upon implementation, the Enabling Virtual Classroom and Text-Based E-Learning Environment undergoes rigorous testing to ensure functionality. Selenium was used for functional testing to measure key performance metrics, including page load time, error rate, CPU utilization, throughput, memory utilization, and response time, utilizing WebDriver's built-in capabilities. The test was executed ten times, and the system produced average values for each performance metric based on these runs. The results were as follows: a response time of 0.809 seconds, throughput of 149.6, an error rate of 0.4, a page load time of 2.21 seconds, CPU utilization of 44.4%, memory utilization of 1200.5 MB, and 117 concurrent users. In conclusion, this project contributes to the global discourse on e-learning innovation, emphasizing the pivotal role of technology in advancing education. Recommendations are made for further research and application, emphasizing the importance of articulating program capabilities and seeking expert advice for optimal utilization.

Keywords: E-learning, virtual classroom, text-based environment, collaborative learning, didactic learning, feedback mechanism, Nigerian education, technology integration.

1. Introduction

The utilization of computers in education emerged with the completion of the first business computer in 1951. Educationalists envisioned linking university classrooms to computers, which would serve as patient tutors, meticulous examiners, and tireless schedulers of instructions. The anticipated benefits for students included the freedom to pursue personalized learning paths at their own pace and convenience, with access to richer learning materials and automated progress assessment.

Learning holds the pivotal role in unlocking our utmost capabilities. In the 21st century, our individual, organizational, and national success hinges upon our aptitude for learning and the adept utilization of acquired knowledge in our daily endeavors (Kulesi, 2014). An increasing number of tertiary educational institutions globally, including colleges and universities, have wholeheartedly embraced electronic learning (e-learning) due to several compelling reasons. E-learning offers cost-effective delivery, interactive features, and round-the-clock accessibility, thereby furnishing convenient and economical avenues for honing skills and advancing careers (Allen, 2006). E-learning encompasses various approaches such

as web-based learning, virtual classrooms, and distance learning. It leverages virtual reality to establish virtual classrooms, libraries, and e-learning environments, facilitating collaborative and didactic learning. Key components include delivering content in multiple formats, managing the learning experience, and fostering a networked community of learners, content developers, and experts. A distance education system brings educational opportunities within reach of individuals and alleviates the pressures and limitations often associated with traditional classroom learning.

The design of a virtual classroom and text-based environment aims to foster flexible learning and create a framework for sharing quality learning materials within the Computer Engineering Department. It supports a blend of synchronous and asynchronous learning methods, with text-based communication facilitated through email, incorporating features such as addressing, ellipses, and signs. The developed system prioritizes user-friendliness, interactivity, and includes a feedback mechanism to ensure effective control and quality learning experiences.

Challenges facing Nigerian university education stem from inadequate facilities such as classrooms, laboratories, and libraries. High student enrollment exacerbates the issue, rendering physical facilities less effective. Lectures are often conducted in suboptimal conditions, lacking proper seating, ventilation, or shelter. Access to library resources is limited, with insufficient and outdated materials. Additionally, funding constraints, salary delays, and strikes disrupt academic calendars, hindering student progress and discouraging academic advancement among government workers.

The discontinuation of satellite campuses further complicates distance learning, making knowledge acquisition difficult and costly.

This paper aims to address these challenges by designing and implementing a virtual classroom conducive to collaborative and didactic learning, integrating feedback mechanisms. It analyzes existing e-learning models to develop a hybrid approach that combines synchronous and asynchronous techniques, offering solutions to the lack of physical facilities in Nigeria's educational landscape.

2. Literature Review

Song et al. (2019) examined the impact of virtual education on classroom culture, particularly focusing on social presence and self-disclosure among students and teachers. The study emphasizes the importance of developing positive relationships and fostering intimacy in virtual settings to improve the overall educational experience.

Andrew et al. (2021) investigated student engagement in synchronous virtual classrooms during the COVID-19 pandemic. They proposed a peer-observation initiative to enhance engagement and address the limitations of the virtual environment, suggesting that peer observation can significantly improve student participation.

Chen et al. (2021) analyzed the effectiveness of virtual classrooms in maintaining student performance and engagement during the COVID-19 pandemic. The study concludes that while virtual classrooms pose certain challenges, they can support learning outcomes effectively when implemented properly.

Smith et al (2019) explored the benefits and challenges of integrating synchronous and asynchronous learning modes in virtual classrooms. Their case study focuses on improving student interaction and flexibility, offering insights into best practices for blended virtual learning environments.

Zhou et al. (2021) discussed using blockchain technology to enhance security and data integrity in virtual classrooms. Their research addresses the challenges of current online education platforms and proposes a blockchain-based solution to improve trust and transparency.

Yin et al. (2021) investigated the effects of biophilic design elements in virtual reality (VR) classroom environments on students' stress levels and cognitive performance. Published in PLOS ONE, the study found that incorporating natural elements into virtual

classrooms can significantly reduce stress and enhance cognitive functions.

Smith et al. (2020) explored the future of remote learning through advancements in virtual classroom technology. They discuss how virtual reality (VR) and augmented reality (AR) can create immersive educational experiences, enhancing student engagement and learning outcomes.

Brown & Green (2018) reviewed the benefits and challenges of virtual learning environments (VLEs). They emphasize the need for effective instructional design and the role of technology in facilitating interactive and collaborative learning.

Johnson & Johnson (2017) assessed the impact of virtual classrooms on higher education, particularly focusing on student performance and satisfaction. Their findings suggest that well-designed virtual classrooms provide a flexible and efficient learning platform suitable for diverse student populations.

3.0 Materials and Methods

The methodology adopted for the development of the "Virtual Classroom and Text-Based E-Learning Environment" involved a comprehensive approach integrating both design and implementation aspects across different dimensions. The process encompassed the utilization of various tools and programming languages such as Basics, HyperText Markup Language (HTML), Visual Basic Programming Language, and FrontPage Express for website development. The primary framework consisted of seven essential pages:

1. Home page
2. Library
3. Requirement
4. Courses outline
5. Objective
6. Method of payment
7. About Enabling Virtual Classroom and Text-Based E-Learning Environment

The core programming language employed for module development was Visual Basic. Each module underwent rigorous testing and execution before integration into the main system. The design was intricate, with interrelated modules functioning seamlessly to ensure a cohesive user experience.

3.1 Input Specification and Designs

The system incorporated various input forms to facilitate easy data entry and updating of information into the website's database. Input forms included:

1. Login form: Enables users to access the system securely.
2. Registration forms: Facilitate user registration by capturing essential information.
3. Send mail form: Allows users to send emails to each other within the system.

These input forms were meticulously designed to ensure smooth interaction with the system. Visual Basic programming language was utilized to control and manage the functionality of each input module.

3.2 Output Specification and Design

Output specifications were tailored to provide users with relevant information based on their input. Outputs included:

1. Check message: Displays notifications, lectures, payment confirmations, and registration confirmations. It comprised multiple forms driven by Visual Basic code, ensuring effective communication between users.

3.3 Procedure Chart for User Aspect

A comprehensive procedure chart was devised to guide users through various system functionalities, ensuring ease of use and understanding.

3.3.1 System Requirements

The development and operation of the system necessitated specific hardware, software, and liveware requirements:

3.3.2 Hardware Requirements:

- Pentium computer and Dual core Computers with necessary peripherals
- Adequate memory and storage capacity (CD – ROM – Speed of 56x, Hard Disk Capacity of 200GB to 1TB, Ram Size – 8GB to 32GB)
- Input devices (light pen, Mouse, Keyboard)
- Output devices (printer, scanner)

3.3.3 Software Requirements:

- Compatible operating system (Windows XP, Win 7, 8 & 10)

- Programming tools (Visual Basic 6.0, FrontPage XP)
- Testing Tools (Selenium)
- Additional software (Adobe Acrobat, TCP/IP)

3.3.4 Liveware Requirements:

- Trained personnel for database administration and system operation

3.4 Site Installation

The installation site played a crucial role in ensuring the system's functionality and security. Factors considered included:

- Adequate power supply and backup systems
- Suitable environmental conditions
- Network connectivity
- Safety measures (e.g., fire extinguishers, emergency exits)
- Compliance with regulations and standards

3.5 Data Flow Diagrams

Figure 3.1 depicts the data flow diagram representing the process of validating users and granting them appropriate roles within a system. The user submits their data to the system. The system processes the data in the "Validate user and grant" step. Once the validation is successful, the user is assigned to one of the three roles (Student, System Administration, or Lecturer), granting them specific access permissions and functionalities based on their role.

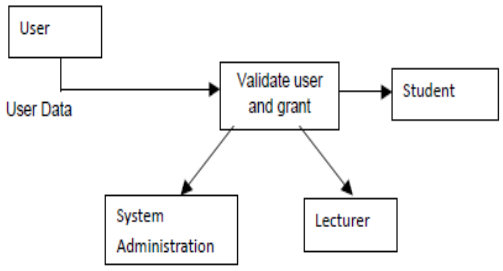

Figure 3.1: Data Flow Diagram Showing the Process of Validating Users and Granting Them Appropriate Roles within a System

Figure 3.2 illustrates the interactions and functionalities available to lecturers within an educational system. Lecturers can create and view course modules, manage assessment questions and solutions, and engage in discussion forums. They also monitor students' performance and course coverage. All relevant data, including questions, student performance, course coverage, and discussion messages, are stored in dedicated data stores. This system ensures organized and efficient data management, enabling lecturers to effectively facilitate teaching and track student progress.

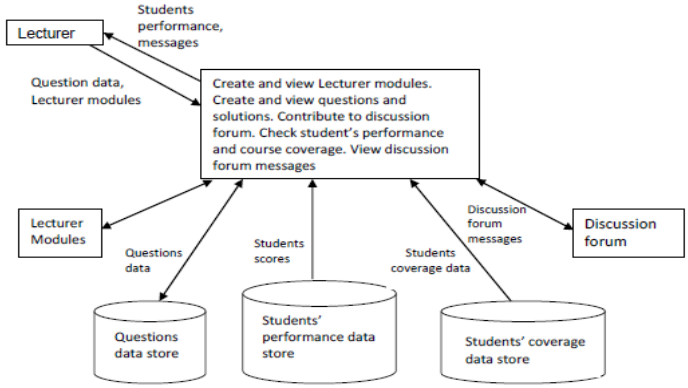

Figure 3.2: Data Flow Diagram Showing the Interactions and Functionalities Available to Lecturers within an Educational System

As depicted in Figure 3.3, Students engage in studying lecture modules, answering questions, viewing solutions, checking their performance, and contributing to discussion forums. Their answers are stored in the Questions Data Store, performance scores in the Students' Performance Data Store, and course coverage data in the Students' Coverage Data Store. Discussion forum messages are managed within the Discussion Forum module. This system organizes all relevant data, allowing students to efficiently manage their studies, monitor their performance, and participate in collaborative discussions, enhancing their overall learning experience.

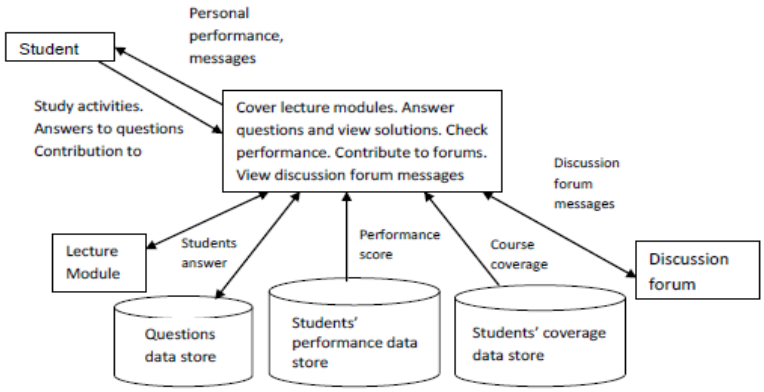

Figure 3.3: Data flow diagram depicts the interactions and functionalities available to students within an educational system.

4.0 Implementation

After planning and designing the "Enabling Virtual Classroom And Text-Based E-Learning Environment," the next step is implementation. This involves incorporating the application into the organization for use and training users to understand and utilize the program effectively. It is crucial to integrate the efforts of users' departments and data processing departments to make the new system operational. Understanding the chosen language and the implementation environment is essential for the sections involved. These considerations are vital in the implementation process:

- Choice of Language: Visual Basic 6.0 was selected for implementation due to its simplicity.
- Programming Environment: The Visual Basic environment is utilized to run the program.

4.1 Program Design

The design of the Enabling Virtual Classroom and Text-Based E-Learning Environment is structured in two dimensions: HTML and Visual Basic program codes. Visual Basic serves as the

anchor of the project, while HTML is used to supplement backup information systems for display purposes. The Visual Basic program is designed in a menu-driven format, offering users various options for different functions or purposes. Flowcharts were instrumental in developing a workable program. The flow chart for the program design is shown in figures 4.1 to 4.12

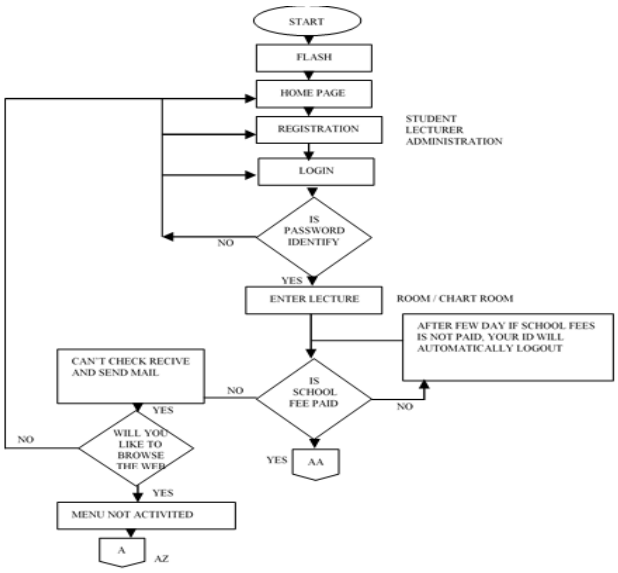

Figure 4.1: Flowchart that Shows the Steps in Accessing the Virtual Classroom Platform

Figure 4.1 describes the steps involved in accessing a virtual classroom platform. It begins with an introductory flash screen leading to the home page, where users can register, log in, or select roles such as student, lecturer, or administrator. Upon login, the system verifies the user's password and, if correct, allows entry into the lecture or chat rooms. The system checks if the school fees have been paid. Unpaid fees result in automatic logout after a few days, while paid fees grant access to additional features like email and web browsing. This process underscores the importance of fee verification for accessing the platform's full functionalities, ensuring that only financially cleared users can fully utilize the services, thus maintaining security and structured access management

.

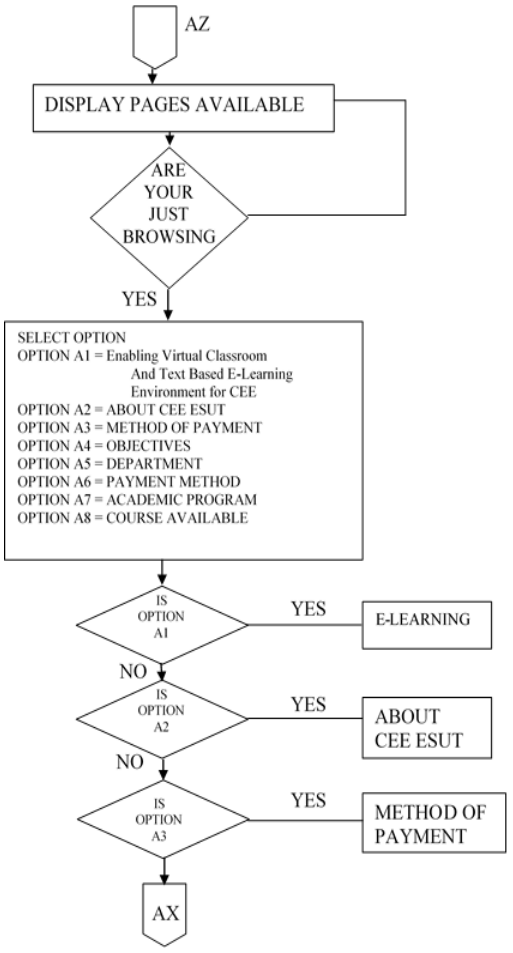

Figure 4.2: Flowchart for User Browsing and Information Access

Figure 4.2 continues the process within a virtual classroom platform, starting from a point labeled "AZ" which displays available pages. It asks if the user is just browsing. If yes, the user is presented with multiple options: enabling the virtual classroom and text-based e-learning environment for CEE, information about CEE ESUT, methods of payment, objectives, department details, another payment method option, academic program information, and available courses. From there, if the user selects option A1, they are directed to e-learning resources. If option A2 is chosen, information about CEE ESUT is provided. Selecting option A3 leads to details about payment methods. The flowchart ensures that users can access specific information or resources based on their selected options, guiding them through the various functionalities and information available on the virtual classroom platform.

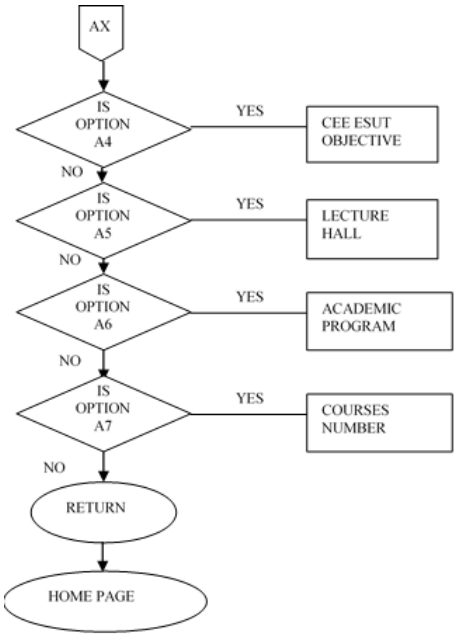

Figure 4.3: User Navigation Check

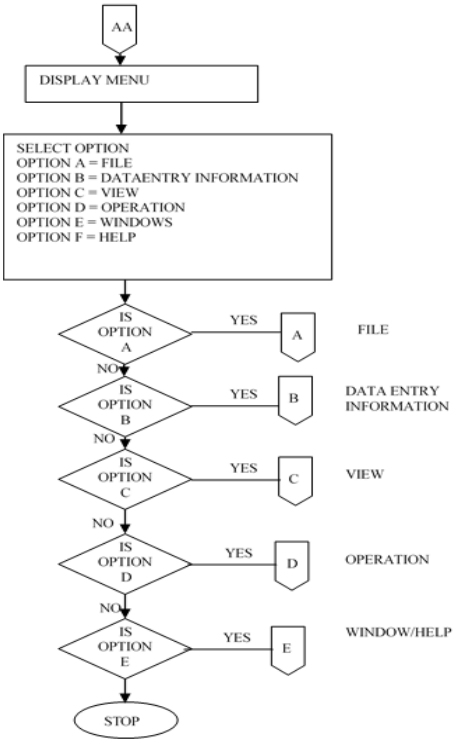

Figure 4.4: Main Menu Navigation

Figure 4.3 continues the process within a virtual classroom platform, It starts with a decision point labeled "AX," which checks several options in sequence: Option A4 (CEE ESUT Objective), Option A5 (Lecture Hall), Option A6 (Academic Program), and Option A7 (Courses Number). If none of these options are selected, the user is directed to return and eventually taken to the home page. Figure 4.4 labeled "AA," involves displaying a menu with several selectable options: Option A (File), Option B (Data Entry Information), Option C (View), Option D (Operation), Option E (Windows), and Option F (Help). Each option leads to a corresponding action or page. If none of the options are selected, the process ends.

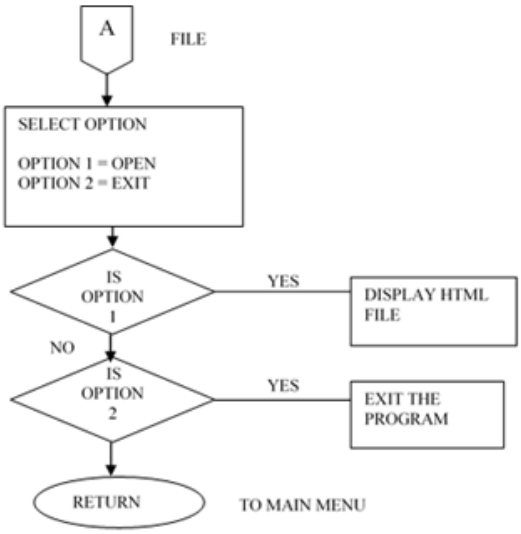

Figure 4.5: File Operations Menu

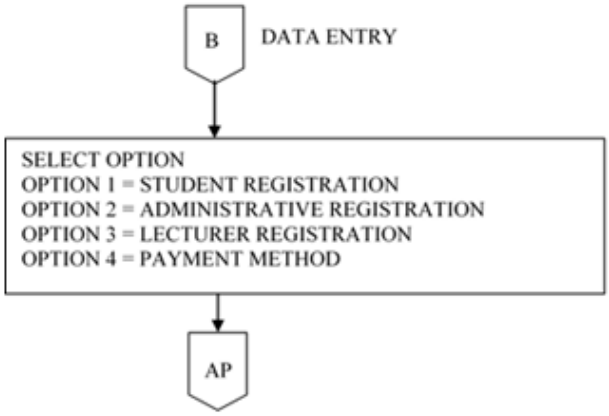

Figure 4.6: Data Entry Options

Figure 4.5 starts with a file operation, offering two options: "Open" and "Exit." If the "Open" option is selected, an HTML file is displayed. If "Exit" is chosen, the program terminates. If neither option is selected, the flowchart returns to the main menu.

Figure 4.6 focuses on data entry, providing four options: student registration, administrative registration, lecturer registration, and payment method. Upon selecting any option, the process continues further, indicated by the connection to another part of the system (labeled "AP").

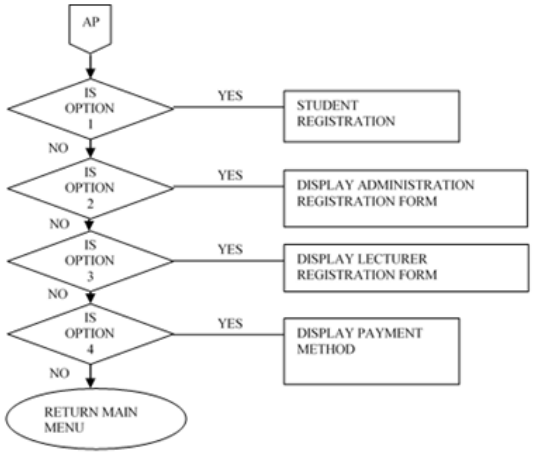

Figure 4.7: Data Entry Options Continuation

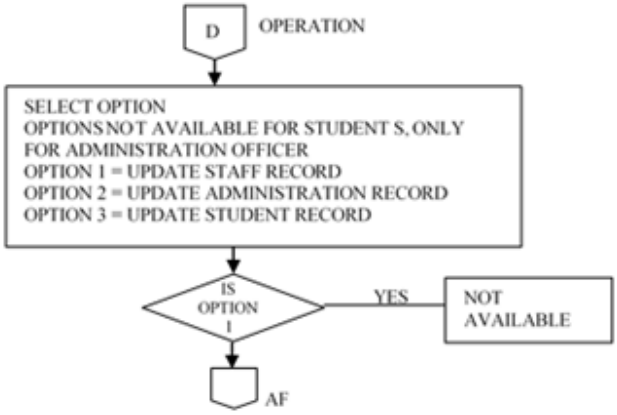

Figure 4.8: Administrative Operations

Figure 4.7 outlines various options and processes for different user interactions within a system. It starts with the user selecting one of four main options. If the user chooses option 1, they proceed to student registration. Option 2 leads to the display of an administration registration form, while option 3 displays a lecturer registration form. Option 4 provides the display of payment methods. If none of these options are selected, the system returns to the main menu.

Figure 4.8 is designated for administrative officers, excluding students, where options include updating staff records (option 1), updating administration records (option 2), and updating student records (option 3). If option 1 is selected, the process moves to the next step; otherwise, it returns to the main menu.

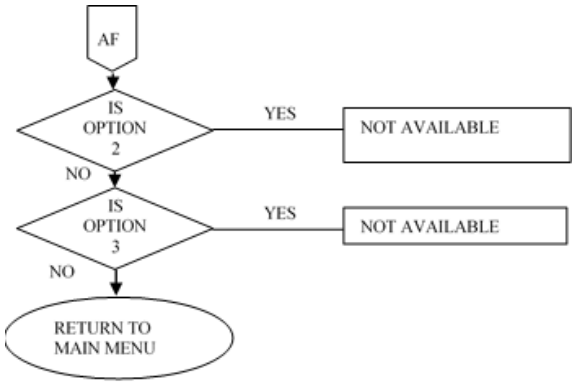

Figure 4.9: Administrative Operations Continuation

Figure 4.9 is a continuation of Figure 4.8, users select options to update records or return to the main menu. Options for updating staff and administration records, as well as student records, are not available for the students. If these options are not selected, the process returns to the main menu

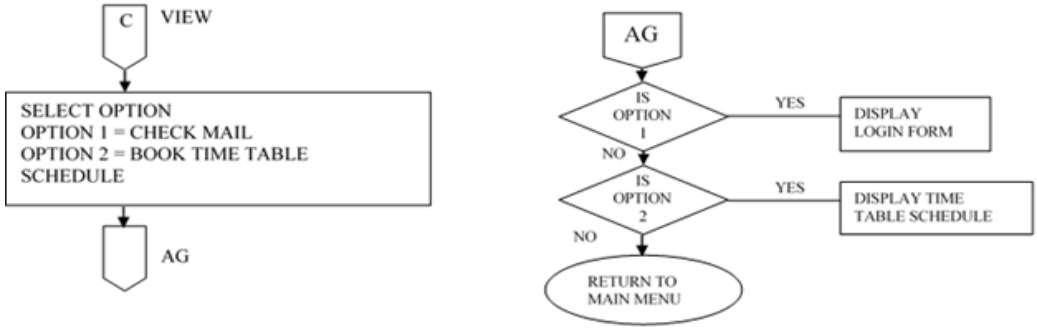

Figure 4.10: Viewing and Scheduling Options

In Figure 4.10, users can select between checking mail (option 1) or booking a timetable schedule (option 2). For these actions, the user is directed to a login form or a timetable schedule display, respectively. If neither option is chosen, the user returns to the main menu.

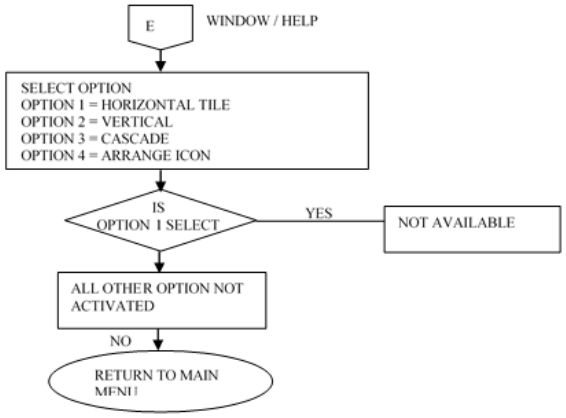

Figure 4.11: Window Management Options

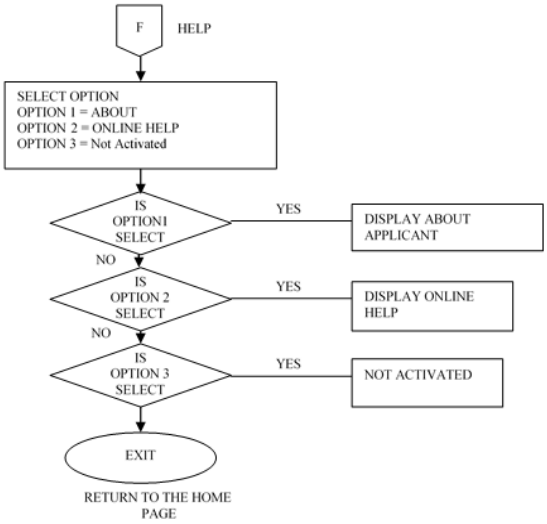

Figure 4.12: Help and Support Options

In figure 4.11, users can select between horizontal tile, vertical, cascade, and arrange icon options. If the horizontal tile option is selected, it is marked as not available, and for all other options not activated, the process returns to the main menu. Figure 4.12 shows the help options. Users can choose to view information about the application, access online help, or attempt an unavailable option. If the "about" or "online help" options are selected, appropriate displays are shown. If none of these options are selected, the process exits and returns to the home page.

4.2 Academic Program

The academic program for the Enabling Virtual Classroom and Text-Based E-Learning Environment is determined based on factors such as need analysis and market surveys. Popular programs such as simulation, computer architecture, cyber security, computer science, games, graphics, 2D and 3D model data analysis, communication, and research are included. The program encompasses study skills with multimedia applications, English proficiency, library and communication skills, computer fundamentals, logic, and creative thinking.

4.3 Test Run

The test run of the Enabling Virtual Classroom and Text-Based E-Learning Environment was conducted with confidence, ensuring that the program met its required outputs. Selenium was utilized for functional testing to measure key performance metrics such as page load time, error rate, CPU utilization, throughput, memory utilization, and response time using WebDriver's built-in capabilities. The test was executed 10 times, and the results are presented in Table 1.

Table 1: Performance Metrics for 10 Test Runs

Test Run	Response Time (s)	Throughput (req/s)	Error Rate (%)	Page Load Time (s)	CPU Utilization (%)	Memory Utilization (MB)	Concurrent Users
1	0.8	150	0.5	2.3	45	1200	100
2	0.9	145	0.6	2.4	47	1250	120
3	0.85	148	0.4	2.1	43	1180	110
4	0.75	152	0.3	2.0	44	1220	130
5	0.8	149	0.2	2.2	46	1210	115
6	0.78	151	0.5	2.3	45	1190	105
7	0.77	153	0.3	2.1	43	1175	125
8	0.82	150	0.4	2.2	45	1205	130
9	0.83	147	0.5	2.4	44	1195	120
10	0.79	151	0.3	2.1	42	1180	115

After the testing, the system produced average values for each performance metric based on the test runs, as shown in Table 2.

Table 2: Average Performance Metrics

Metric	Average Value
Response Time (s)	0.809
Throughput (req/s)	149.6
Error Rate (%)	0.4
Page Load Time (s)	2.21
CPU Utilization (%)	44.4
Memory Utilization (MB)	1200.5
Concurrent Users	117.0

These averages indicate that system performed very well under the given test conditions, providing a clear picture of its efficiency and capacity to handle user load.

5.0 Summary, Conclusion and Recommendation

This project provides the necessary information to improve user understanding of the purpose and usage of the designed program on a network, thereby achieving its objectives. Further research could enhance the system's usefulness and ease of use.

Modifications can be made to the system after studying it comprehensively. Although various storage options exist, such as diskettes, hard disks, and CD-ROMs, the project's size necessitates storage on a large capacity device like a hard disk.

5.1 Delivery Format and Mechanism

The project on the Design and Implementation of Virtual Classroom and Text-Based E-Learning Environment will be delivered through lectures and course materials developed in sequence using conceptual or modular themes. Study centers equipped with local area networks (LANs) will facilitate training, learning, assessment, communication, internet access, and access to the National virtual library.

5.2 Conclusion

The incorporation of the Enabling Virtual Classroom and Text-Based E-Learning Environment project has significantly improved global technology communication and education. E-learning has become a valuable opportunity for individuals to advance via the internet. This project contributes to various aspects of life and education through technology innovation.

5.3 Recommendation

It is crucial to clearly articulate the capabilities, reliability, and durability of any established program to create awareness and promote its usage. The Enabling Virtual Classroom And Text-Based E-Learning Environment can be utilized in information websites, legal education systems, nursing schools, and other educational organizations requiring online

methods. Future researchers should integrate machine learning models and artificial intelligence to improve the system's robustness, enabling more intelligent and adaptive learning experiences. Features such as screen readers, Braille displays, and audio descriptions should be implemented to assist blind students.

Speech-to-text functionalities and communication tools tailored for speech-impaired students should be integrated to ensure inclusive participation.

References

Allen, R. (2006). Psychology and instructional technology. In R. Glaser (Ed.), Training research and education (pp. 45-67). New York, NY: Wiley.

Kulesi. (2014). The potential take up of mass training. In R. Winterburn (Ed.), Aspects of educational and training technology (Vol. 24, pp. 112-130). London, England: Kogan Page.

Andrew, L., Wallace, R., & Sambell, R. (2021). A peer-observation initiative to enhance student engagement in the synchronous virtual classroom: A case study of a COVID-19 mandated move to online learning. Journal of Educational Technology Development and Exchange, 14(2), 56-68.

Brown, M., & Green, T. (2018). Virtual learning environments: Benefits and challenges. Journal of Educational Technology Systems, 47(1), 27-38. https://doi.org/10.1177/0047239518784507

Chen, Y., Hong, K., & Liu, Z. (2021). Virtual classrooms and student performance: A study of online learning during the COVID-19 pandemic. International Journal of Educational Technology, 38(4), 222-235. https://doi.org/10.1080/02680513.2021.1934187

Johnson, D., & Johnson, R. (2017). The role of virtual classrooms in higher education. Journal of Higher Education, 88(3), 245-256. https://doi.org/10.1080/00221546.2017.1367057

Smith, T., Jones, A., & Lee, B. (2019). Blending synchronous and asynchronous learning in a virtual classroom environment: A case study. Journal of Interactive Learning Research, 30(1), 5-23. https://doi.org/10.1080/10494820.2019.1565797

Smith, J., Lee, K., & Brown, A. (2020). Virtual classrooms and the future of remote learning. Journal of Educational Technology, 49(2), 112-124. https://doi.org/10.1080/00131881.2020.1771830

Song, H., Kim, J., & Park, Y. (2019). The influence of virtual education on classroom culture. Educational Technology Research and Development, 67(5), 1263-1280. https://doi.org/10.1007/s11423-019-09721-6

Yin, J., Yuan, M., Fu, X., & Liu, Y. (2021). Biophilic classroom environments on stress and cognitive performance. PLOS ONE, 16(3), e0248953. https://doi.org/10.1371/journal.pone.0248953

Zhou, Y., Ling, W., Wang, X., & He, Q. (2021). The design and implementation of a virtual classroom based on blockchain technology. Journal of Educational Technology Development and Exchange, 14(3), 56-72. https://doi.org/10.1080/10494820.2021.1948945