AN OBJECT-ORIENTED MODEL FOR A DYNAMIC LEARNING ENVIRONMENT IN VIRTUAL CLASSROOMS

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Abstract

Due to societal constraints and inadequate institutional resources, distance learning emerged as a vital solution for expanding education access, particularly for working adults. Traditional methods like correspondence, radio, and television proved ineffective, prompting the development of online distance learning platforms. To address these challenges, the Delta State Polytechnic Ogwashi-uku introduced DSPGvirtual, a web-based e-learning platform utilizing streaming technology. This prototype enables learners to access real-time or on-demand video lectures, online materials, and internet resources from remote virtual classrooms. The methodology utilizes Moodle-Cloud technology to develop a real-time distance learning platform. The design is made up of the home page interface, my course, student's timeline, course categories, session interface, course resources and forum activities, while the model was implemented using PhP and run on a web server. The evaluation show improvement in teaching and learning experiences, minimize overcrowding in classrooms, enhance student-lecturer interaction and utilize streaming technologies for real-time learning. Thus, the model will improve teaching and learning if embrace.

Keywords: Virtual Classrooms, streaming, E-Learning, distance education, learning management system.

Introduction

The rapid growth of student enrolment in higher institutions has exacerbated infrastructure challenges, leading to overcrowded lecture theatres and inadequate learning facilities. Traditional teaching methods face significant obstacles, including insufficient voice systems, writing boards, and lecture rooms. To address these issues, this project leverages Moodle-Cloud technology to develop a real-time distance learning platform, facilitating effective communication between students and lecturers regardless of location. The integration of Information Technology (IT) has revolutionized learning, with e-Learning emerging as a prominent mode of education. Distance learning enables students to study remotely, while media streaming allows for real-time video and audio transmission. This project exploits these technologies to create a virtual learning environment. E-evolution or e-revolution (Palvia, 2023) has witnessed e-mails, e-commerce, e-government, and now e-education. E-education or online education is changing the way we approach teaching and learning. Dziuban et al., (2016) describe the evolution of online education in four phases using primarily USA context: 1990s (Internet propelled distance education), 2000–2007 (increasing use of Learning Management Systems – LMS), 2008–2012 (growth of Massive Open Online Courses – MOOCs), and beyond with growth of online higher education enrolments outpacing traditional higher education enrolments.

Real-time activities have been one of the driving forces of active distance learning platform for delivery of events. Learning classroom and facilities, over the years has not increased proportional to the number of students admitted yearly into the higher institutions; this has led to jam packed

lecture theatres and ill learning environment as teaching facilities such as the voice system, writing board, the lecture room and the likes are not sufficient enough to teach the large number of students the polytechnic/university has. Most learning activities such as assignments, teaching, term paper, research work has face a lot of challenges which has in one way of the other make learning uninteresting. This project is developed to simulate the face-to-face technique of teaching into real-time platform where students and lecturers can communicate more effectively even at different locations. Leveraging on the existing technology, this system is built using the Moodle-Cloud platform which provide the live-streaming facility that help lectures share video, slides and give answers to student question while the video conference is going on.

Distance learning is a way of studying in which learning takes place remotely without the physical present of either the lecturer or the student or both. Media streaming is either a video or an audio file received and sent to a client while been delivered by the sender whereby the receiver does not need to download the file before access to view the content. This happens because the media is sent in a continuous stream of data so viewers can watch as it arrives, while on-demand video is viewed after the video has been recorded and downloaded. Media streaming network for distance learning however is based on how to leverage on the existing network in the institution so that lecturers can teach from strategic location and broadcast to students in their various classes in real time with the advantage of students having access to the lecture videos at later times for reference purpose. In present times, there exists different ways of learning, there are online classes for various courses, with different motives and different learning platforms. Considering the present learning environment and the growing number of students available at tertiary institutions, there is need for most tertiary institution to build bigger lecture theatres that will conveniently contain the number of students the institution has. But this will in turn demand a high charge of money from the institution's purse. In addition to this most institutions do not have adequate voice support system to aid learning in class. This has constructed a big gap between lecturer and student as many students are discouraged about asking question during class and eventually after class. These challenge can however be combated with the use of streaming technologies that is now available over the internet. With this, lecturers can lecture and share slides with thousands of students from their office or a more convenient environment while student in various lecture halls can learn at a better convenience. In addition, the use of forum will further aid student-lecturer relationship as students and lecturers can relate on a forum, discuss topics, share ideas and other educational activities which might be general or designated. The objectives of this research are to improve teaching and learning and minimize crowded classroom, Enhance student-lecturer interaction and Leverage streaming technologies for real-time learning.

Related Works

Palvia *et al*. (2023) published an article title "Online Education: Worldwide Status, Challenges, Trends, and Implications". The paper reviewed the need for LMS due to advances in technology, internet adoption, and the need for a digitally skilled workforce. By 2025, online education is expected to become main stream. This editorial highlights key country-level factors influencing online education which includes Industry and business, Government policies and laws, ICT capacity and infrastructure, Internet and mobile technology adoption and Income and digital divide. The article highlights the impact of these factors on quality and quantity of online education. The editorial also provides implications for countries and global organizations to support the growth and development of online education.

Salas-Pilco *et al*. (2022) evaluated the engagement in online learning in Latin American higher

education during the COVID-19 pandemic period via a systematic review of 23 studies. They considered three dimensions of engagement, including affective, cognitive, and behavioural engagement. They described the characteristics of learning engagement and proposed suggestions for enhancing engagement, including improving Internet connectivity, providing professional training, transforming higher education, ensuring quality, and offering emotional support. A key limitation of the review is that these authors focused on describing the characteristics of engagement without identifying factors that influence engagement.

Grafton-Clarke *et al.* (2022) investigated the innovation/adaptations implemented, their impacts, and the reasons for their selections in the shift to online learning in medical education during the pandemic period via a systematic review of 55 articles. The major adaptations implemented include the rapid shift to the virtual space, pre-recorded videos or live streaming of surgical procedures, remote adaptations for clinical visits, and multidisciplinary ward rounds and team meetings. Major challenges encountered by students and teachers include the need for technical resources, faculty time, and devices, the shortage of standardized telemedicine curricula, and the lack of personal interactions. Based on this, they criticized the quality of online medical education.

TCIL (2006) presented a guide for selecting instructional media in distance learning, highlighting streaming technologies' potential. The Ethiopia Pilot project (2006) demonstrated this concept, delivering IGNOU's Tele-education services to 40 students from Addis Ababa and Haramaya Universities. However, the project lacked robust course management software. Akintola and Akinyokun (2011) designed a multimedia network system for Nigerian universities' e-Learning. The framework leverages streaming technology, HTML, and mobile technology to provide; Online/on-demand lectures, two-way communication, and cross-platform compatibility. The system architecture comprises lecture capture, viewing, and storage components, enabling interactive and accessible learning. Akintola et al. (2012) developed a mobile learning framework for ubiquitous course access. The architecture utilizes mobile networks and WAP, enabling students to access learning materials and notifications via mobile devices. Notably, video integration was not explored.

In Wowza (2016), a Streaming Engine that provides robust, scalable server which powers reliable high quality video streaming to any device anywhere in the world is presented. The motivation for this work is to deliver any media to any device, anywhere. Wowza streaming engine is multithreaded software that delivers live and ondem and streaming from standard on-site hardware or through the cloud, letting the user make the most of his hardware, networking and other resources. El-Seoud (2017) proposed an integrated education management system via cloud computing, combining ERP with university functionalities. The system features self-registration, teacher access, and resource management. Five subsystems facilitate learning, library, student records, finance, and HR management. However, it lacks support for lecture videos.

Analysis of the Existing System (Research Gap)

Akintola's (2011) work was critically analysed using a three-tiered work system approach. This holistic methodology reveals system malfunctions can stem from various factors beyond technology, including user inexperience, information gaps, and infrastructure inadequacies. The work system method provides a comprehensive framework for identifying and addressing systemic issues. Also, it was reported in the same work (Akintola, 2011) that system faces usability and technical issues, including: slow video transmission, assignment submission difficulties, connectivity problems due to non-standardized technologies, high operational costs (internet, power), steep learning curve, lack of support, collaboration tools, and user-friendly interface, no

internal email services. these challenges hinder the system's performance, leading to user dissatisfaction. this paper aims to address some of these issues.

El-Seoud,(2022) also lacks video streaming capability. Moodle is a learning management facility that aims to solve some of these problems. The research gaps such as Poor performance, accessibility barriers, Non-user-friendly interface, high operational costs, Limited collaboration tools for distance learners among others are what the researchers intend to bridge using the developed online model called DSPGvirtual that have ease navigation, interactive, user friendly and portable with any operating system and so on.

Research Methodology

The LMS model which is called is MOODLE enables learners to access real-time or on-demand video lectures, online materials, and internet resources from remote virtual classrooms. The interfaces are easily navigable, interactive, user friendly and portable with any operating system. However, addition of more features in the model a system with 2GB and core i3 processor is needed. There are some limitations to this research work which are low resolution of camera, and reliable internet facilities.

System Design (MOODLE)
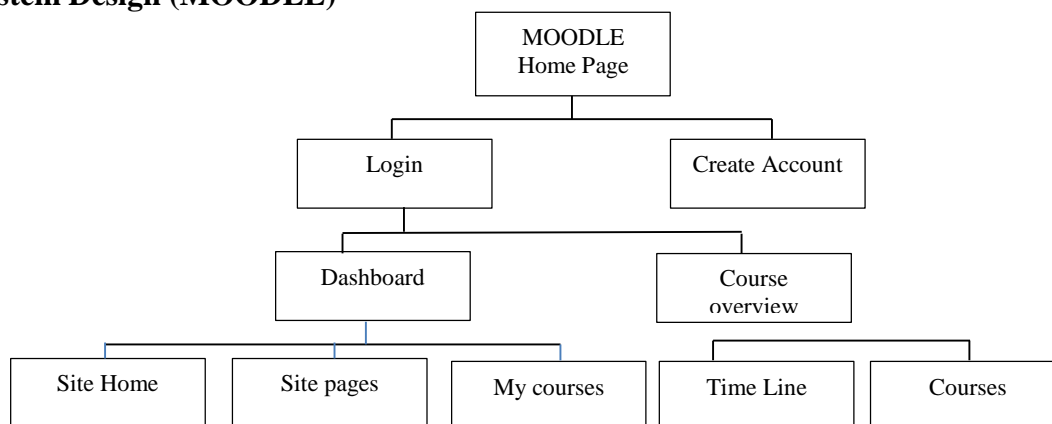
Figure 1: The home page interface of the MOODLE

Figure 1, shows how the DSPGvirtual.edu website is designed to display, the login and create account page immediately the website is loaded. Old users are prompted to login using the existing username and password created while creating a new account. New members are however prompted to fill in some information, for example name, email address, address, username and password. For new users, the website displays a prompt addressing the user to confirm the account in the registered email address, on confirming the account, the user is directed to the next page which contains the dashboard and the course overview. Old users are directed to the page which contains the dashboard and course overview. The dashboard contains navigation to the site home, site pages and "my courses" which is the student registered courses, students are able to navigate to desired registered courses. The timeline consists of students' activities, while the courses, and displays the various courses the students is participating, has participated or will participate in. Figure 2 displays the navigation through the "my courses" the page displayed first the announcement which helps teachers communicate necessary information to the students on what is supposed to be done. Thereafter the course contents are displayed in terms of topics or weekly design. Figure 2 is the architecture of My Course.
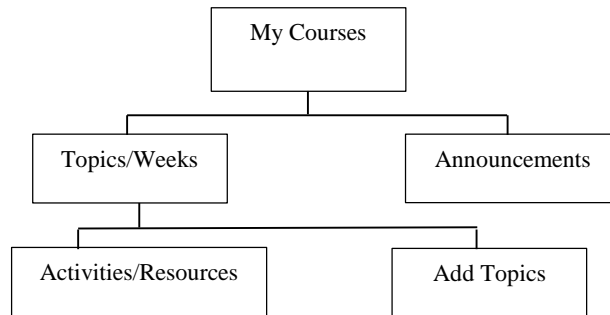
Figure 2: Architecture of My Course

The topic is displayed as "Introduction to programming" for example while the weekly design is displayed as "Jan 01 – Jan 07(Week One)". From the course content, student can reach the activities and resources available. On the other hand, teachers can add topic from the administrative side.
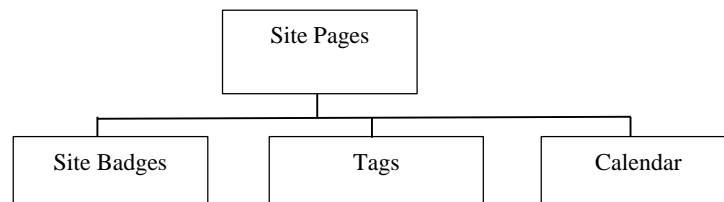

Figure 3: The extra Resources of the site page

Figure 3 shows how the "site pages" acts as a navigation button, pointing to the site badges, tags, and calendar, these are additional resources provided to aid the student with better interaction and experience. Figure 4 is the Student's Timeline.
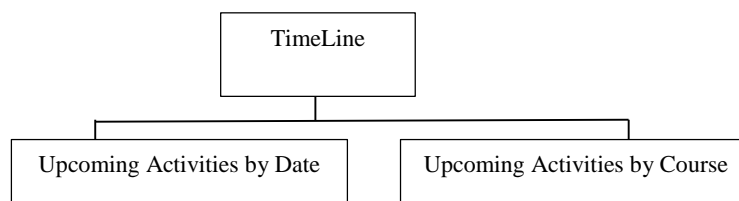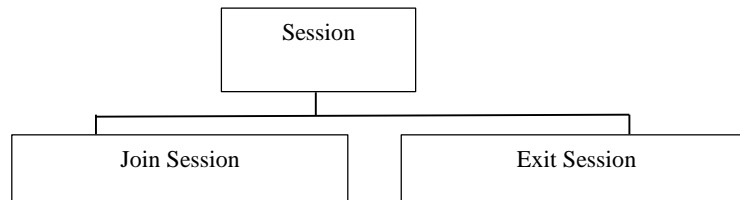

Figure 4: Student's Timeline

Figure 4 explains how the timeline appears after the student log into the website; it reveals the student's activities which can be categorised by date or by courses. The date category shows all upcoming activities regardless of the course according to date of occurrence while the course category displays the upcoming activities according to the registered course. This acts as a source of reminder to student on what is supposed to done. Figure 5 is the Course categories.
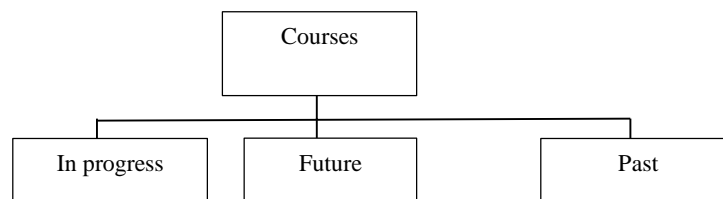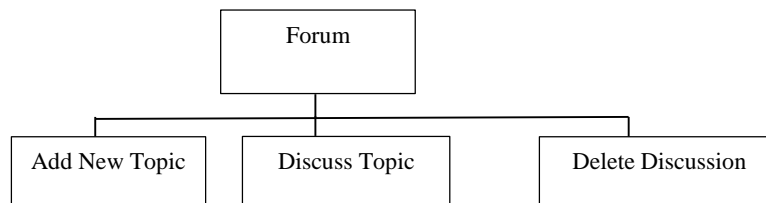

Figure 5: Course Categories

Figure 5 shows the courses interface displaying the courses the student is partaking in, will partake in and had taken. The "in progress" section displays the courses the student offers, while the "future" displays courses to be later and "past" displays the course taken by the student. While the next window shows the activities of the website, which are tasks assigned to the student by the lecturers, they perform various options which include getting feedback, giving assignment, discussion to mention a few. These activities help lecturers keep track of student's learning ability and pace, assists in lectures and other learning aspect.

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                    ┌─────────────────┐
                    │     Session     │
                    └────────┬────────┘
              ┌──────────────┴──────────────┐
      ┌───────────────┐           ┌───────────────┐
      │  Join Session │           │  Exit Session │
      └───────────────┘           └───────────────┘
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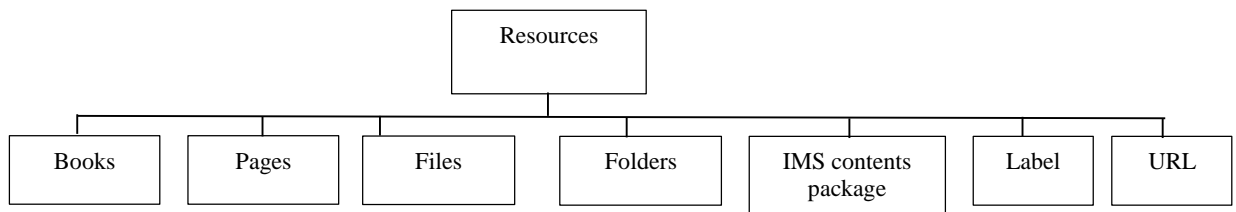
Figure 6: The Session Interface

Figure 6 explains the video streaming capability of the Moodle Cloud is designed to function in a way student can join a session created by the administrator or teacher. The student is first entitled to join the streaming section after which can exit session when the session is closed or at will. Teachers on the other hand can kick out student who are seen as disturbance.

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                    ┌─────────────────┐
                    │     Forum       │
                    └────────┬────────┘
        ┌──────────────┬─────┴──────────────┐
┌───────────────┐ ┌──────────────┐ ┌──────────────────┐
│ Add New Topic │ │ Discuss Topic│ │ Delete Discussion│
└───────────────┘ └──────────────┘ └──────────────────┘
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Figure 7: Forum Activities in the MOODLE

Figure 7 explains that the forum section allows students to discuss relevant topic or matter with themselves which sometimes might involve the teacher, this create an avenue for a good lecturer student relationship. It also helps with announcement. The student can perform the following operation on the forum; add new topic, this enables students add whatever topic needed to be discussed on the forum with description. Other students can reply on or discuss this topic. Topic added by user can also be deleted by the user who created it.

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                         ┌─────────────────┐
                         │    Resources    │
                         └────────┬────────┘
   ┌──────┬──────┬──────┬─────────┴──┬──────────┬──────┬──────┐
┌──────┐┌──────┐┌──────┐┌────────┐┌────────────┐┌──────┐┌──────┐
│Books ││Pages ││Files ││Folders ││IMS contents││Label ││ URL  │
└──────┘└──────┘└──────┘└────────┘│  package   │└──────┘└──────┘
                                  └────────────┘
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Figure 8: Course Resources of the website

Figure 8 lists out the website various resources which enables easy learning and navigation in the website. These resources points or holds activities in the website and are to be accessed by

System Implementation

In order to improve this system, a modular object oriented dynamic learning environment

(MOODLE) is proposed. This is a web technology that enables a group of users of different background to collaboratively maintain and organize a website in an effective manner. Learning management system (LMS) are programmed in programming languages such as PHP and runs on a web server. LMS content are stored in a database such as MySQL which is open source or POSTGRESQL and this content includes text, graphic files and some other files to be published.

Features like a search engine, forum, and email integration are also incorporated. The Moodle is a free learning management system written in PHP and it provide an easy way to upload and share materials, hold online discussions and chats, give quizzes and surveys, gather and review assignments, as well as record grades. This is a type of Web Content Management which is majorly an e-learning platform with a robust database and functionalities that will aid learning such as forum, sharing of file and access to educational materials.

Moodle as a Learning Management System (LMS) provides various platforms to aid distance learning. This platform, today, has been used together with some other applications example is the red5 server for the purpose of media streaming. Over the years Moodle has developed different versions with increased functionalities and integrations. The Moodle website can be setup manually or online, for the sake of this research, the website is setup online with the aid of the Moodle Cloud platform. The Moodle Cloud platform is an online hosting platform for Moodle websites.

Configuration of Moodle Website

To configure a Moodle website online there are certain basic system requirements to be put in place, such as:
a. Internet facility
b. Processor: 1GHz (min), 2GHz dual core or more recommended.
c. Memory: 512MB (min), 1GB or more is recommended.
d. 8 GB plus hard disk is likely on a large production server.

With these basic requirements in place, the administrator will then visit the Moodle Cloud website www.moodlecloud.com for proper configuration. Here, the administrator is given the choice of different plans which are Moodle for free, starter and schools at different price range. The price range differs as a result of number of students that will be making use of the platform, the file storage, plugins and some other additional functionality.

Structuring of a Moodle Cloud Website

Structuring the MoodleCloud website takes a bit of arrangement, addition and manipulation of each function, the next section will be looking at putting necessary arrangement in place for a functional MoodleCloud website. To make changes to the MoodleCloud website, the administration window has the "Turn editing mode on" which is to be activated for editing permission on the website. Figure 9 is the prompted form to register/add a course

Figure 9: The prompted form to register/add a course

Course creation: In other to create courses on the MoodleCloud platform, the turn editing on feature must be turn on so that administrator can make changes to the website. The "add a new course" button is clicked and the "add new course form" is prompted by the website for the administration to fill appropriately. Administrator is entitled to make necessary changes to the course as shown in figure 9.

Adding resources and activities: The Moodle activities and resources ranges from assignment, forum, chat, quiz, glossary, feedback, lesson, external tools, and these activities help in creating interactive class between students and lecturer for the purpose of learning. To integrate any of this activity on any section or week by the administrator, the following process is used:

Step 1: Make sure block editing is turn off or turn editing is on
Step 2: Click on "add resources". Figure 10 is the prompted window of "add activity or resources"
Step 3: Choose which resources or activities to add
Step 4: Follow the prompt and fill appropriately
Step 5: Submit the filled form by either clicking on "save and display" or "save and proceed" to course.

The format of the prompt varies depending on the selected resources. To integrate activities or resources, follow the steps outlined earlier, but expect differing prompts as illustrated in Figure 10. MoodleCloud, a robust learning management system, facilitates distance learning through various platforms. It replicates face-to-face interaction, bridging the gap between students and lecturers. As previously discussed, MoodleCloud's key features create a seamless digital teaching experience, fostering close engagement between educators and students.
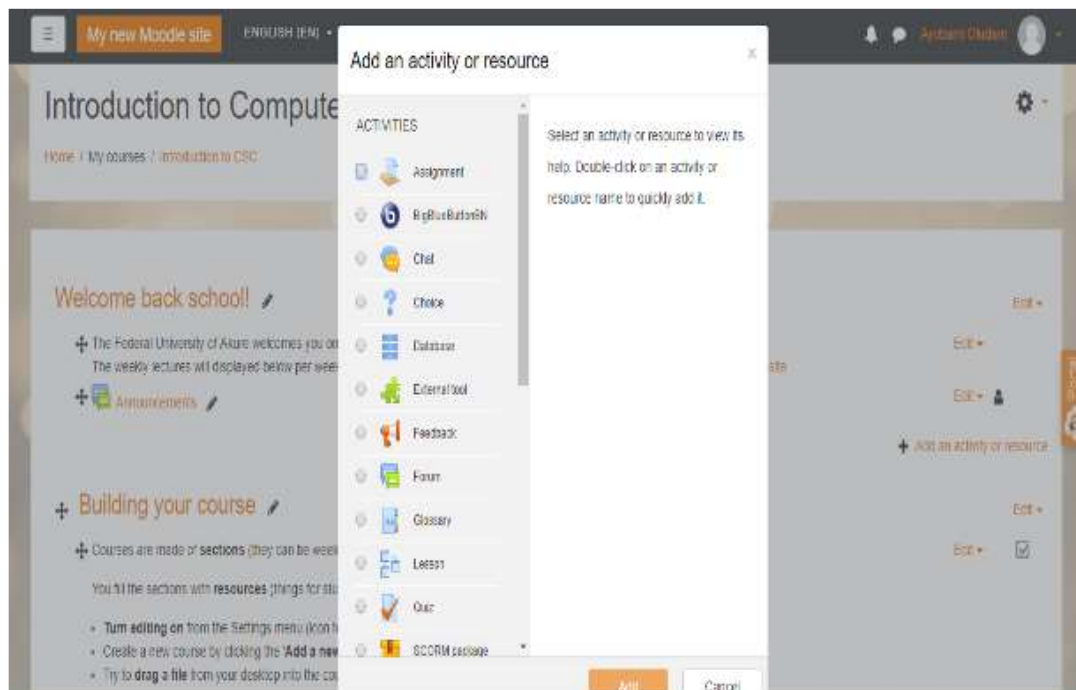
Figure 10: The prompted window of "Add activities or resources

Exploration of the Moodlecloud Website

The MoodleCloud features, if used maximally, gives optimal results that aids distance learning, bringing lecturers and student close enough to the face-to-face classroom feel.

Signup Page The MoodleCloud platform enables user create an account and subsequently allow user log into the MoodleCloud website with the account details created on the platform. This is to help administrators, teachers keep record of students that are on the platform, and statistics of students registered and enrolled in a course thereby keep guest at the guest level. It is also used for authenticating and keeping each student's account private preventing phishing and other fraudulent act as shown in figure 12.

**Figure 12:** The signup page for distance learning. moodle cloud.com

Home Page: This is the first page after the user logged into the website, this gives the general

overview of the student courses, activities and every other necessary information the student needs. Here, the navigation pane is visible to student and can be used to navigate to every other part of the website. Students are given privilege to customize their personal page as it suits them with the "customize this page" button at the top-right corner of the webpage as shown in figure 13.
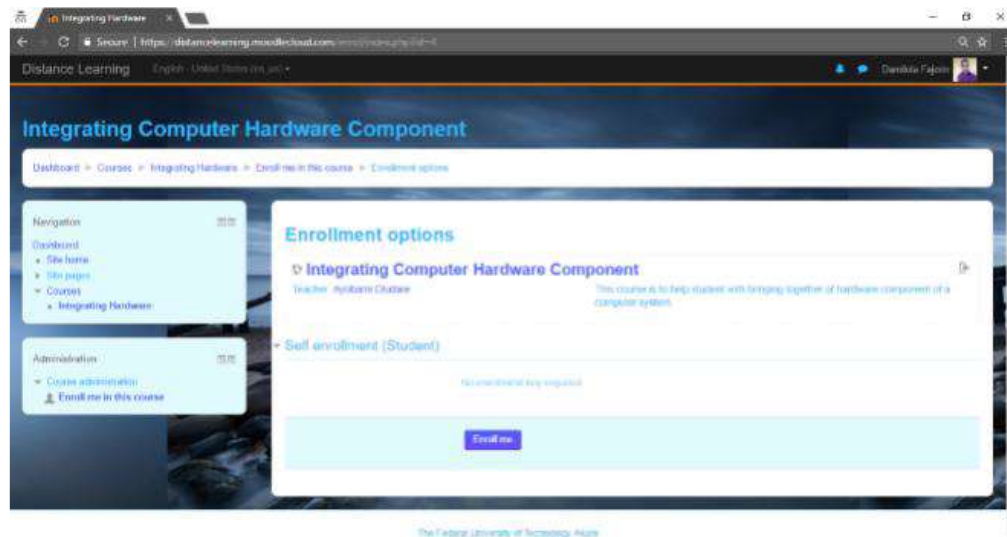

Figure 13: The first page after the user's first login

Course Enrolment: Student after signing up or login will have to enrol into desired course(s), this is because student might not offer every course on the website, and therefore automatic enrolment of student in all courses might not be helpful as student will be enrolled in courses they do not want. This in turn help teachers knows the number of students in a class. Enrolment can be either manually by the administrator or self-enrolment by the student. Student will only gain access to courses on the MoodleCloud website only if they are enrolled in the courses as shown in figure 14.
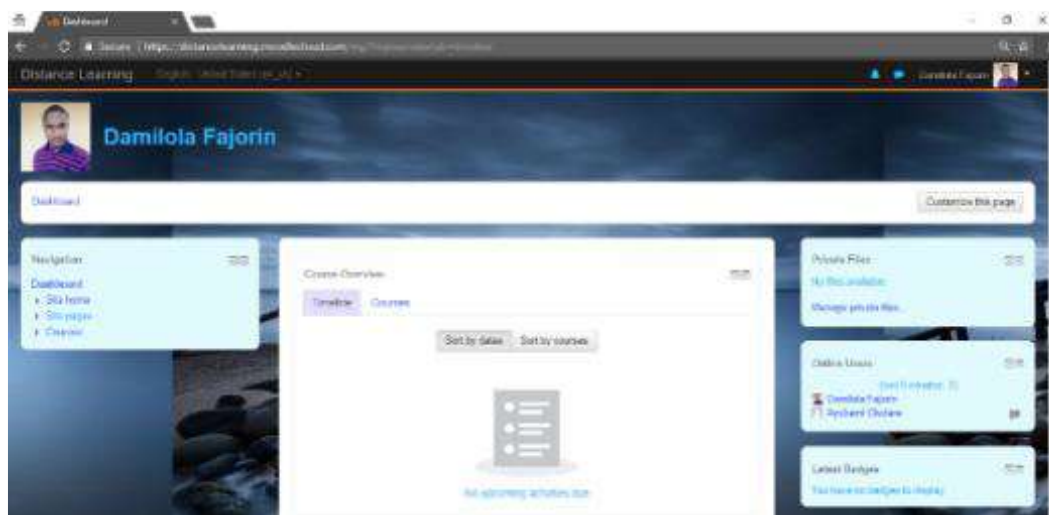
Figure 14: Enrolment page of a course
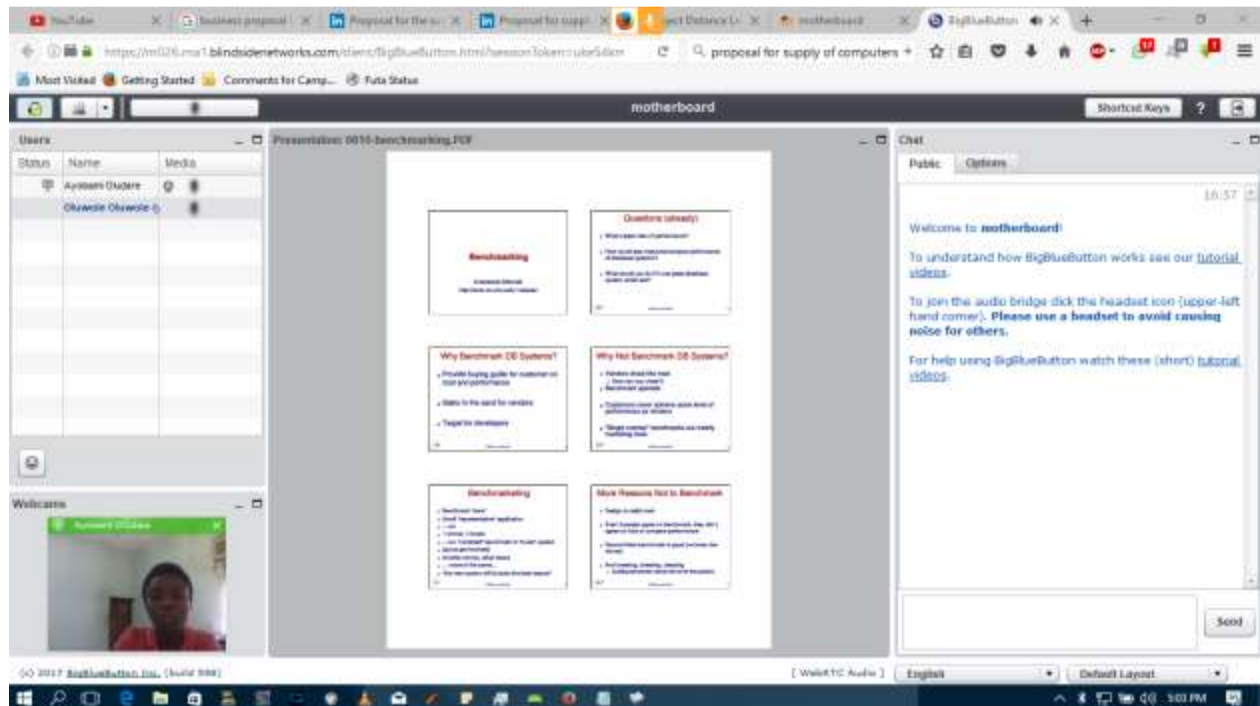
Figure 15: Live streaming with sharing of slides

Live Streaming: This is done with the aid of Big Blue Button, students are able to connect with the lecturer, and experience interactive section through the chat feature available, share camera, react to the lecture going on and ask questions either directly or through the chat platform which can be either be privately or publicly as shown in figure 15.

Conclusion

Learning at every level involves both lecturers and students, however, technology is playing a major role in improving learning so knowledge can be passed down to the next generation. Technologies like use of the projector, tablet has been adopted, however, are not efficient as there is limited gadgets to support the large population. In this project, a web application was developed which has support for live lecture streaming, forum, evaluation, e-books and links to other resources. The application developed on the MoodleCloud platform possesses other functionalities to aid distance learning in various learning institute. However, for continuous use of this platform, and more functionality like the on-demand video, giving of certificate and the likes, the institution will have to pay and subscribe for bigger plan of the MoodleCloud plans. In summary for the smooth running of the model the following requirements must be available;

a. Internet facility
b. Processor: 1GHz (min), 2GHz dual core or more recommended.
c. Memory: 512MB (min), 1GB or more is recommended.
d. 8 GB plus hard disk is likely on a large production server.

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