WEB-BASED VIRTUAL CLASSROOM SYSTEM MODEL FOR COMPUTER SCIENCE EDUCATION PROGRAMME IN NIGERIA

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INTRODUCTION

Virtual Classroom according to Atasi (2008) is a teaching and learning environment located within a computer mediated communication system. It consists of assets of group communication and work “spaces” and facilities that are built in software. Brown et al (1989) opines that learning, both outside and inside school, advances through collaborative social interaction and the social construction of knowledge. Students need to learn by interacting with their peers so that knowledge can be constructed. The modern web technology provides enabling environment for students to explore knowledge as well as the communication convenience for them to interact. Virtual learning environments are hugely diverse in size, capability and services offered and can cater for individuals ranging in attainment, ages and special needs. Virtual classrooms are of three broad categories – independent, collaborate and broadcast (Atasi et al, 2008). Web-based learning approach has come to stay. It not only has dealt with standard but also classroom-based environment. This learning approach has raised the stake on how well the benefits of collaborative learning will be properly harnessed in a web-based environment. Collaborative learning according to Zhao et al (2008) means that knowledge is not something that is delivered to students, but rather something that emerges from active dialogue among those who seek to understand and apply concepts and techniques. With collaborative learning environment there is enhanced student – student interaction which may contribute to the achievement of educational goals by influencing educational motivation and aspirations through peer relationships (Hilz, 1993). Kaye (1994) posits that to collaborate means to work together, which implies a concept of shared goals and an explicit intention of “add value” – to create something new or different through a deliberate and structured collaborative process as opposed to simply exchanging information or passing on instructions. Web-based Virtual Classroom System (VCS) provides the platform or structure for effective collaborative learning through which quality knowledge in various forms and approaches can be gained.

ABSTRACT

There has been out-cry nationwide about the persistent decline in the quality of our education in Nigeria an indication that the current teaching and learning approaches in use in our institutions have failed. The need to improve the quality of computer science education currently imparted in our Education system has therefore become imperative. Based on our findings, a mathematical model Web-based Virtual Classroom was developed to provide a viable medium through which sound ICT education can be offered by our colleges of education that can cater for varieties of learners - those who are unable to attend school due to treatment for chronic illnesses; who are at risk for educational failure due to intermittent school attendance. Our system is designed based on active learning approach that adopts blended learning theory (Constructivist-Cognivist learning approach), incorporating e-pedagogy that supports varied learning styles and learning strategies through fostering of collaboration among participants in the web-based Virtual learning environment. Our system has an architecture composed of backend engine (based on MySQL server database engine) on Apache web server and a frontend engine. The logical design is modeled with the UML; the application is implemented using the PHP programming language.
RELATED WORKS

A lot of research work has been conducted and their results established, learning opportunities offered through the virtual classrooms far outweighs that obtained in the traditional classroom environment. Paratone and McCormack (1997) present research that indicates peer tutoring projects are successful. Technologies have been applied to provide feedback. Strasser (1993) discusses how E-mail is used to improve communication between student and instructor. Love and Mckean (1993) present a real-time student feedback system where students can request several actions from the instructor. These actions include speaking faster or slower, using less technical language or summarizing, and so on. In the system, students record their requests by pressing a particular key.

The internet has extended the boundaries of the classroom creating new opportunities of tapping the numerous benefits that web-based classes and other distance learning approaches offer. Web based virtual online classroom is designed and developed based on learning theories and streaming media technologies (Zongkai et al, 2007). Zongkai and Qingtang present a web-based virtual classroom as composed of two parts: Instructional Communicating Environment (ICE) which provides learners with learning materials, lecture videos, and interactive environment etc; and Collaborative Learning Environment (CLE) which supports active learning by providing the environment with learning tools, learning materials and contextual discussion for learners, with all the environment designed with event based synchronous strategies and e-learning technologies standards. Bernie (2008) describes the use of a web based interactive software called WebQuests. A WebQuest presents an interactive environment with activities that are inquiry-oriented in which some or all of the information that learners interact with emanates from resources on the internet. Carina (2002) presents a virtual classroom that was designed to increase student’s attention, motivation and communication. The virtual classroom was based upon a learning management system (LMS). The LMS has features for collaborative learning, testing and evaluation. First Class is a very popular conferencing system. Web browser is used to access its features which has both real-time (synchronous) and delayed time (asynchronous) resources. Facilities available in First Class include Mail, Chat, shared documents, bulletin board, conference and discussion groups and so on (McConnell, 2000). Learning Space is a course-authoring environment for web-based teaching and learning. It includes both synchronous and asynchronous facilities as well as group and individual spaces. Some of the outstanding features of learning space include: CourseRoom, Schedule, Mediacenter, Profiles, Assessment Manager, and Learning Server (Zhao and Kanji, 2008). Kimberly et al (2008) present a system called WebCT. WebCT is a web-based authoring and electronic communications system that was developed at the University of British Columbia. It has a bulletin board system, which allows users to discuss matters of interest and post information to each other. Other features of WebCT include web-based tools (authoring pages of text, graphic, etc.). Chat (real-time discussions that can be logged), email facilities for individuals (as well as group mailing list facilities), and conferencing facilities (thread discussions) (McConnell, 2000).

WebICL (Web-based Collaborative Learning system) is a system presented by Zhao and Kanji (2008) that was modeled and designed based on collaborative learning theory and collaborative learning process. The system design is made up of six components – register, learning group, knowledge learning, teacher’s role, evaluation, and collaborative learning tools. Adewale (2007) presents a University Digital Libraries Adaptive, Personalized E-learning system, which is an adaptive system that monitors particular learner’s behaviour and characteristics based on these; the system compiles resultant and adapted documents from larger universal source documents, the adapted documents are then presented to the learner. The systems reviewed serve the purpose for which they were developed. However there are noticeable limitations, such as:

- Most of the systems focused more on activities involving the learners only.
- Instructors contribution or level of involvement in the teaching and learning process is not adequately captured.
- Group formation for collaborative studies is not open (some are done based strictly on students with the same learning style).
- Interactive communication support tools (e.g video conferencing) are lacking in the system in most of the system.
- No single system can be used to manage all the academic activities and records of students and entire classes throughout the entire academic programme (NCE, degree).

Our work is a mathematical model web-based virtual classroom system is related in function to all the systems being examined and described above. It is an improvement and a realization of Zhao and Kanji (2008) WebICL (Web-based Collaborative Learning system) framework model based on programming. Our Web-Based Virtual Classroom System (WebVCS) model is an integrated collaborative learning system based on the active learning approach which applies the experiential learning theory. According to our study, experiential learning method is very important to enhance the quality of web-based collaborative learning. That is convergent, divergent, assimilative and accommodative learning style.

We adopted the classical scheme where e-learning systems are divided into three logical units: users, knowledge database, and learning environments. These units are then connected and combined to deliver material and to offer optimal learning conditions (Chellali et al, 2009). There are Eight modules in the WebVCS which they are CourseRoom, Schedules, MediaCentre, Learning, Profile, Assessments, Administrative and Database module. The new WebVCS is modeled to transfer a traditional classroom on a network. The activities that are involved in the WebVCS include learning activities, groups formation, contributions/authoring, evaluation/assessments, browsing, creating and editing of user profile, all taking place in a web-based environment that make
THE WEBVCS MODEL DERIVATION

The key objects used in creating the WebVCS model are: Courses, Students, Instructors and Learning performances.

Let \( CO_k \) be courses to be undertaken by the students where \( i = 1,2,3 \) (students’ year of study – NCE 1, NCE 2, NCE 3) and \( k = 1,2,3, \ldots, n \) (\( k \) is the course number registered for). Each course syllabus is split into topics (\( t_o \) and \( t = 1,2,3, \ldots, t \), the topics \( t_o \) are in turn split into subtopics (\( SO_m \) and \( m = 1,2,3, \ldots \) (lesson units or pages or screens))

Let \( S_j \) - represents the various students of the course \( CO_k \), \( j = 1,2,3, \ldots, N \), \( N \) - total number of students who registered for the course \( CO_k \), Let \( P_{ik} \) - represents students’ learning performance in course \( CO_k \), and \( W_d \) represents contributions to the overall WebVCS learning process such that

\[
\sum_{d=1}^{n} W_d = 100\% \quad \ldots \ldots \ldots (1)
\]

Student’s Overall Learning Performance in the Web-based Virtual Classroom is given as:

\[
P_I = \sum_{i=1}^{k} \sum_{j=1}^{N} W_d(g_d(CO_k, S_j) + \sum_{z=1}^{Z} G(A_{ik})) \quad \ldots (2)
\]

Where:

\( g_d(CO_k, S_j) \) = a function that returns student \( S_j \)'s contribution or performance in collaborative/group studies in the course \( CO_k \)

\( G(A_{ik}) \) = a function that returns student \( S_j \)'s performance in other forms of assessments – tests, attendance, quiz, project etc.

\( W_d() \) = a function that returns each student \( S_j \)'s overall contribution or performance in the classroom activities.

\( i = \) student’s year \( (i = 1,2,3 = \text{NCE1, NCE2, NCE3}), k = \) courses registered \( (k = 1,2,3, \ldots, n) \), \( n = \) total number of courses registered

\( j = \) students for the course \( CO_k \) \( (j = 1,2,3, \ldots, N) \), \( N = \) total number of students who registered for the course \( CO_k \)

\( z = \) student \( S_j \)'s other forms of assessment – tests, attendance, quiz, project etc. \( z = 1,2,3, \ldots \)

Instructor’s Level of Involvement in the Web-based Virtual Classroom is given as:

\[
W(I_k) = \sum_{t=1}^{x} V_{ln}(SO_{lm}) \quad \ldots \ldots \ldots (3)
\]

Where \( t = 1,2,3, \ldots, x \) (course topics), \( k = \) courses registered \( SO_{lm} = \) subtopics, \( m = 1,2,3, \ldots \) (lesson units or pages)

Then the Web-Based Virtual Classroom Mathematical Model is given as:

\[
\text{WebVCS} = \sum_{j=1}^{N} P_s \sum_{k=1}^{n} W(I_k) \quad \ldots \ldots \ldots \ldots (4)
\]

Complete courses consist of various learning objects that meet different educational needs. As shown in figure below, learning objects are represented as an object (web page) which are packaged into higher granularity objects (such as topics), the learning objects are also used to construct subtopics, topics of modules, and eventually curriculum. Each topic (to (or) subtopic \( SO_{m} \)) is presented to the student using a web page for efficient learning. The basic assumption of the WebVCS is that one or more to, \( SO_{m} \) shall be covered within a lecture schedule.

The structure of the \( CO_{ik} \) is shown in fig.2 below.

Students’ Overall Performance in Courses

\( P_z \) (assessments): where \( z = 1,2,3, \ldots \) To determine the overall performance of the student \( S_j \) on course \( CO_{ik} \) at the end of a particular semester, certain parameters such as performances in class attendance \( (A_{ik}) \), assignments \( (A_{ik}) \), tests \( (A_{ik}) \), final examination \( (A_{ik}) \) and collaborative studies evaluation \( (g_d) \), are employed. Each topic \( (t_o) \) or subtopic \( (SO_m) \) is associated with a minimum time \( T_{im} \) in which student \( S_j \) of various categories ought to have spent in the classroom to be able to learn properly topic \( (t_o) \) or subtopic \( (SO_m) \). \( T_{im} \) has an optimal value of 1 (that is a student participated in all the online class activities) and as student moves away from this optimal point, his score decreases at the rate shown below.

\[
\text{Overall Performance} = 0\% \leq \sum_{d=1}^{n} W_d \sum_{z=1}^{n} P_{dz} \leq 100\% \quad (5)
\]
Students’ Level of Participation

A student’s study performance (class participation) is then obtained as follows:

\[
A_{ki} = \frac{1}{n} \sum_{i=1}^{n} T_{lm}(SO_{lm}) \quad \text{…………………… (6)}
\]

\[
T_{lm} = \begin{cases} 
1.00 & \text{for } 20\text{ min} \leq T_{lm} \leq 30 \text{ min} \\
0.75 & \text{for } 15\text{ min} \leq T_{lm} \leq 19 \text{ min} \\
0.50 & \text{for } 10\text{ min} \leq T_{lm} \leq 14 \text{ min} \\
0.25 & \text{for } 5\text{ min} \leq T_{lm} \leq 9 \text{ min} \\
0.00 & \text{for } T_{lm} < 5 \text{ min} \quad \text{(Adewale, 2007).}
\end{cases}
\]

Other parameters that are used in determining the performance of students of the WebVCS include collaborative studies, assignments, tests and final examination covering all the concepts learned in the course (CO). The assessment provides factual information about the student’s knowledge, that is, how much knowledge the student has acquired and as well his involvement in the WebVCS.

Student’s Assessment Score Determination

The total score from the various other assessment methods used on the student is given as: \( P_{k} = \sum_{z=1}^{n} G(A_{z}) \) ……… (7)

Where \( G \) is a function that returns the score associated with \( A_{z} \).

Collaborative Study Assessment

Let students \( S_{j} \) be the ones that registered for the course \( CO_{k} \). After the close of registration for the semester, the students are automatically formed into small learning groups as may be specified by the administrator.

\[ g_{iq} = \text{groups, } q = 1, 2, 3, \ldots \ldots \text{ gp} \]

Then, each student’s (S’s) collaborative study performance in the groups \( g_{iq} \) is obtained using the formula below:

\[ P_{k} = W(g_{iq}(CO_{k}, S_{j})) \quad \text{…………….. (6)} \]

Where \( W \) is a function that returns the group/collaborative score obtained by the student \( S_{j} \) based on the contributions he made in the group \( g_{iq} \).

Measure of Instructor’s level of Involvement in the WebVCS

The instructors \( I_{k} \) are assigned to courses \( (CO_{k}) \). Each topic (to) or subtopic \( (SO_{lm}) \) is associated with minimum time \( V_{lm} \) in which the instructor \( I_{k} \) of the course \( CO_{k} \) ought to have spent in the WebVCS to ensure proper mentoring and classroom administration. \( V_{lm} \) has an optimal value of 1 (that means the instructor was all available throughout the WebVCS sessions) and as the instructor moves away from the optimal point his level of involvement decreases. Each instructor’s level of participation in the WebVCS is determined as follows:

\[
I_{k} = \frac{1}{n} \sum_{i=1}^{n} V_{lm}(SO_{lm}) \quad \text{……………… (8)}
\]

\[
\begin{align*}
V_{lm} &= \begin{cases} 
1.00 & \text{for } 25\text{ min} \leq V_{lm} \leq 35 \text{ min} \\
0.75 & \text{for } 20\text{ min} \leq V_{lm} \leq 24 \text{ min} \\
0.50 & \text{for } 15\text{ min} \leq V_{lm} \leq 19 \text{ min} \\
0.25 & \text{for } 10\text{ min} \leq V_{lm} \leq 14 \text{ min} \\
0.00 & \text{for } V_{lm} < 10 \text{ min}
\end{cases}
\end{align*}
\]

For example, for the first student \( j = 1 \) in NCE1, his overall Learning Performance \( (P_{j}) \) in the Web-based Virtual Classroom is given as:

\[
P_{j} = W(g_{11}(CO_{11}, S_{1}) + G(A_{11}) + g_{12}(CO_{12}, S_{1}) + G(A_{12}) + g_{13}(CO_{13}, S_{1}) + G(A_{13}) + \ldots \ldots \ldots g_{nZ}(CO_{nZ}, S_{N}) + G(A_{nZ}))
\]

THE WEBVCS OVERALL SYSTEM DESIGN

The system receives input from users – students, instructors, administrator and visitors. The students level of involvement in the lessons (class participation/attendance) is received, his performances or involvement in collaborative studies and other learning activities are obtained by the system from the ‘student’ module. The system also obtains data from ‘instructors’ module like the results of various assessments (quiz, test, exams, project) on the students, the instructor’s level of participation in the virtual classroom activities, finally it gathers information from ‘administration’ module to determine the efficiency of the system, i.e. the performance statistics and other system evaluation measure built into the system. All these data are gathered at the end of the session and evaluated accordingly to determine whether the WebVCS is successful or not.
The Web-based Visual Classroom System Activities
The sequence of activities within the WebVCS is clearly illustrated in the UML activity diagram shown below. The activities diagram shows the workflow from the start to the finished point detailing the many parts that exist in the progression of events contained in the system.

![Activities diagram of WebVCS](image)

WebVCS Implementation Technology
The technological approach adopted for the development of the WebVCS is an integration of web technology, database technology and programming technology, using open source solution (Apache, MySQL and PHP) running on Linux operating system. The version of Apache used for the system is 2.0.50, with features for password-protected pages for a multiple of users, customized error pages, virtual hosting for different IP addresses mapped to the same server, directory index directive to multiple files and many more. PHP 5.0 is the version used for development of the system. It is a server-side scripting language that makes our web site to be truly dynamic. MySQL 4.0.20 is the version used for the development of the system. It is the database construct that enables PHP and Apache to work together to access and display data in a readable format to a browser. MySQL according Elizabeth et al. (2005) is the perfect choice for providing data via the internet because of its ability to handle heavy loads and its advanced security measures. The WebVCS consists of eight modules – CourseRoom, Schedules, MediaCentre, Learning, Profiles, Assessments, Administrative and Database module.

CONCLUSION
This research has successfully produced a customized Web-based Virtual Classroom System (WebVCS) that will provide a viable alternative to the teaching/learning system in Nigeria. A successful implementation of this research will reverse the decline in the quality of education in Nigeria especially at the lower level (Pre-primary, primary and lower secondary) and produce ICT competent youths that will drive the nation forward. However, the following measures have to be put in place for optimum realization of the objectives of this research. Internet facilities and computers should be made available even in remote communities of our country; Collaborative efforts are required among various agencies of government saddled with the responsibility of managing the education system so as to produce a commercialized version of the WebVCS.

Further research on WebVCS should focus on extending its features to incorporate learning activities in other forms of education and other disciplines at all tiers of our educational system.

References


