Web-Based Virtual Classroom System Model for Tertiary Institutions

by

Ibam Emmanuel Onwuka. B.Sc. (UNN), M.Sc. (ABU), Ph.D. (FUTA, in-view)
Department of Computer Science
Federal College of Education Kano-Nigeria
ibamemmanuel@yahoo.com


Abstract
The number of students enrolling in various academic programs in our tertiary institutions has continued to grow without a proportionate improvement in learning infrastructure. A learning environment model that provides equal opportunities for all categories of learners in our tertiary institutions irrespective of their learning style, disposition and aptitude has therefore become inevitable. Our system model is developed based on e-pedagogy with enhanced features for collaboration among participants (instructors and students) in a web-based learning environment. Instructor, course, student and learning performance formed the major objects used in developing our system model. Features of our system model include course outline, presentation, resources, assessment/opinion poll, chat, hands-up, students’ list, course info, and collaborate, all harnessed to achieve experiential learning among students.

Introduction
The educational scene in Nigeria today is faced with many crises which are the products of many factors (Adamu, 2002). At the tertiary education level, the major ones among these factors include: explosive increase in the number of enrolments for various academic programs, problem of teaching and learning quality, financing of tertiary education, obsolete system of managing teaching and learning. With over 317 tertiary institutions and various recognized training institutes in the country admitting students from all over the federation and from neighboring countries, with paucity in funding of education enterprise and out-dated learning management system in place in our tertiary institutions today, one wonders what will be the fate of our tertiary institutions and their graduates in the face of global competitiveness driven by ICT.

Students on various campuses of our tertiary institutions are facing certain level of challenges that affect their participation in classes and learning performance generally. Some of these students may be physically challenged, hospitalized due to illness or may be involved in one type of job or the other to be able to meet up with their financial needs. Web-based learning therefore offers interesting opportunities and democratic advantage to these categories of students. Web-based virtual classroom system (WebVCS) provides the platform for effective collaboration among participants (Instructor and Student) in the classroom. Through this medium quality knowledge in
various forms and approaches can be gained. 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. 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.

Learning opportunities offered by the WebVCS may be as good as that of traditional classroom or even better.

To address some of the challenges students of tertiary institution face, we propose to design and develop a WebVCS model based on active learning approach. Our system model is intended to provide the much needed framework for WebVCS developers. Our WebVCS will emerge as a viable tool for fostering collaborative learning through which quality knowledge is gained or constructed among participants.

**Web-Based Virtual Classrooms**

The birth of online learning can be traced to the concept of Self Directed Learning (SDL). When SDL is applied to formal education contexts, it is often seen as a means to shift from a teacher-centered to a learner-centered approach to education (Michael and William, 2003). Virtual Classrooms are designed based on the active learning approach that appears to provide a more effective learning strategy. In active learning approach, students become the “architects of their own learning”. The underpinning of this approach is experiential theory (Verity (1994), Graham (1992)).

**The WebVCS Learning Pedagogy**

Pedagogy can be defined as a combination of knowledge and skills required for effective teaching. It refers to the strategies, methods and styles of instruction. To have effective web-based learning requires a comprehension of the process by which students learn and interact with technology. Online learning requires a different approach also known as Virtual Pedagogy or e-pedagogy. Web-based learning pedagogical frameworks are still evolving. Effective utilizing of web-based learning pedagogical frameworks lead to development of higher order learning and critical thought among students. These attributes are achievable through reflective and collaborative work and assessments using online tools such as groups, asynchronous, discussion boards and synchronous communications – virtual classrooms and conference rooms.

Generally three models of learning pedagogy exist for e-learning: Maye’s Conceptualisation Cycle, Laurillard’s Conversational Mode and Salmon’s E-tivities. Our WebVCS adopted the Maye’s Conceptualisation model. Maye states that learning with technology involves a cycle of conceptualization, construction and dialogue. Maye’s model involves three stages he called the conceptualization cycle. Stage one or Level one: e-learning conceptualization stage (students given information). This involves exposing students to other peoples’ ideas or concepts, for example, reading lecture notes or seeing images or videos. Stage two: e-learning construction stage (students perform task). Here, students apply these new concepts in the performance of meaningful tasks. For example, in answering a quiz, participating in polls, or writing a journal online. Stage three: e-learning dialogue stage (students given feedback). Here, new concepts learnt are...
tested during conversation with instructor or peers. The feedback helps the students resolve erroneous conceptions. The feedbacks or answers to quiz can be given by the instructors through discussion board.

The WebVCS Architecture

The WebVCS is modeled based on e-learning logical units: Users, knowledge database and learning environments. The design consists of eight modules – CourseRoom, Schedules, MediaCenter, Learning, Profiles, Assessments, Database and Administrative module. Activities in the WebVCS include – Registration (User profile, group formation), Create Presentation (authoring/contribution), Start Presentation, Attend Presentation, End Presentation, Collaborative, and so on.

![Diagram of WebVCS Architecture]
The WebVCS Model

The WebVCS model is a mathematical model given as:

- Let $CO_{i,k}$ represents courses undertaken by students where $i = 1,2,3, \ldots x$ (students’ year of study/class/level) and $k = 1,2,3, \ldots n$ ($k$ is the number of courses registered by the student).
- Let $S_{j,i}$ represents the various students for the course $CO_{i,k}$, $j = 1,2,3, \ldots N$ ($N$ is the total number of students who registered for the course $CO_{i,k}$).
- $z$ represents student $S_{j,i}$’s other forms of assessment – tests, attendance, quiz, project, etc. ($z = 1,2,3, \ldots, Z$).
- Let $I_{i,k,r}$ represents the various Instructors assigned to the courses $CO_{i,k}$.
- Let $l = 1,2,3, \ldots, L$ (number of topics in the course $CO_{i,k}$), $m = 1,2,3, \ldots$ (lesson units or pages from the topics $L$).

Student’s overall average performance in the courses’ activities of the WebVCS is given as:

$$P_{j,i} = \frac{\sum_{k=1}^{n} W_{j,i}(g_{j,i}(CO_{i,k}, S_{j,i}) + \sum_{z=1}^{Z} G_{j,i}(A_{k,z}, i))}{n \ldots (l)}$$

$g_{j,i}(CO_{i,k}, S_{j,i})$ = a function that returns student $S_{j,i}$’s contribution/performance (assessment) in collaborative/group studies in the course $CO_{i,k}$.
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\[ G_{j,i}(A_{k,z}) = \text{is a function that returns student } S_{j,i}'\text{'s performance in other forms of assessments – tests, class attendance, quiz, project etc.} \]

\[ W_{j,i}(g, (CO_{k,i}, S_{j,i})) + \sum_{z=1}^{4} G_{j,i}(A_{k,z})_{j,i} = \text{is a function that returns the weight of each student’s} \]

\( (S_{j,i}'\text{'s}) \text{ performance in all the classroom activities (group studies, class attendance, tests, projects etc.) in a course } (k) \text{ for a particular class/level } (i). \)

\[ A_{k,z} - \text{represents a student’s performance in a course’s other mode of assessment outside collaborative/group studies such as: } z = 1 \text{ for class attendance, } z = 2 \text{ for assignments, } z = 3 \text{ for tests, } z = 4 \text{ for final exams, etc.} \]

**If \( z = 1 \) (class attendance) Then \( (A_{k,z}) = V_{l,m} \)

Then, \( P_{j,i} \) gives his average learning performance in all his registered courses for a particular class/level \( (i) \).

Each student’s average level of participation in a course’s online session (class attendance only) is given as:

\[ (A_{k,z})_{j,i} = \frac{1}{L} \sum_{l=1}^{L} V_{l,m}(SO_{l,m}) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \rdots
Recall: \( l = 1,2,\ldots,L \) (course topics), \( k = \) course registered (on online session) \( m = 1,2,3,\ldots \) (lesson units or pages), \( y = \) number of instructors assigned to teach the course \( CO_{i,k} \).

\[
y = \begin{cases} >1 & \text{(team)} \\ 1 & \text{(individual)} \end{cases}
\]

If the course is taught by more than one instructor; that is team teaching, \( y \) will have a value greater than 1. But if it is one instructor per course; that is individual teaching, \( y \) will have a value of 1.

All Instructors’ average level of participation in a course’s online sessions is given as:

\[
\varnothing(I_{i,k,r}) = \frac{\sum_{r=1}^{y} (I_{i,k,r})}{y} \quad \ldots\ldots\ldots (5)
\]

\[
T_{l,m} = \begin{cases} 1.00 & \text{for} \ 25 \text{ min} \leq T_{l,m} \leq 35 \text{ min} \\ 0.75 & \text{for} \ 20 \text{ min} \leq T_{l,m} \leq 24 \text{ min} \\ 0.50 & \text{for} \ 15 \text{ min} \leq T_{l,m} \leq 19 \text{ min} \\ 0.25 & \text{for} \ 10 \text{ min} \leq T_{l,m} \leq 14 \text{ min} \\ 0.00 & \text{for} \ T_{l,m} < 10 \text{ min} \end{cases}
\]

**Observation:**

When the instructor starts presentation, the time \((T_{l,m} \text{ and } V_{l,m})\) starts counting for every student who has logged on and admitted by the instructor as well as the instructor himself. The maximum time for each online session of a course is 30 minutes for students and 35 minutes for instructors. The extra 5 minutes for the instructor is to enable him eject all students he has admitted into the online session at the end of the lecture.

The WebVCS model is therefore given as:

\[
S_i = F\left(\sum_{j=1}^{N} P_{j,i} \sum_{r=1}^{y} \varnothing(I_{i,k,r})\right) \ldots\ldots\ldots\ldots (6)
\]

Recall: \( i = 1,2,3,\ldots,\chi \) representing the class or level of study of the academic programme (e.g. \( i = 1 \): indicates level one or year one class, and so on)

This model captures the average learning performances of all the students in a class or level as well as the level of participation (online session/class attendance) of all instructors for a course of that class or level.

To get average learning performance of all students of an academic programme (all classes/level) as well as level of participation (class attendance) of all instructors in the programme is given as:
\[ \beta = \left( \sum_{i=1}^{x} S_i \right) / x \ldots \ldots (7) \]

To get overall average learning performance of all students in a course for a class or level we have:

\[ \alpha_i = \frac{\sum_{j=1}^{N} P_{j,i}}{N} \ldots \ldots (8) \]

To get overall average learning performance of all students in all courses for all classes or levels of an academic programme we have:

\[ \alpha = \left( \sum_{i=1}^{x} \alpha_i \right) / x \ldots \ldots (9) \]

**Features of the WebVCS Session**

- The instructor can create the session in the beginning and will conduct online presentation in the session. The students can attend the session using the name (course code) of the session and view the presentation made by the instructor.
- The users of the web-based virtual classroom during the lecture session can perform various functionalities as follows:
  - **Course Outline:**
    The instructor creates the course outline in the beginning of the session.
  - **Presentation**
    - In the instructor interface, the presentation screen allows the instructor upload the presentation file. It also allows him to navigate between the slides.
    - In the student interface, the presentation screen will display the slide that the instructor is explaining.
  - **Resources**
    - The instructors can share their resources using the load resources facility that is incorporated in the instructor interface. The resources can be files of various types - doc, rtf, PDF, jpeg or web links (URL).
    - The students can download these shared resources on their machines, also they can access the given web links through their web browsers.
  - **Assessment/Opinion Poll**
    - The instructor can ask the students questions by using the assessment functionality that will be inform of objective or yes/no question type. The response of the students can be of type public or private.
    - The student will be able to submit his response to the test question or poll submitted by the instructor.
  - **Chat**
- The instructor uses the chat functionality to send text messages to the students during session. The instructor can send a message to particular student (unicast or multicast) or to all students (broadcast).

- The students will be able to send text messages to each other during session. But he will not be able to send message to instructor directly during session. He can do that by using another facility – the hands-up facility activated only during session.

- Both instructor and the students can communicate freely after live session by using ‘Collaboration tools’, which supports synchronous (sound and video) communication and asynchronous communication (e-mail messages in text, sound and video format).

- **Hands-up**
  - The instructor interface consists of hands-up list, which will display the names of the students that raised their hands to ask instructor question or need clarification on the concept being taught.
  
  - A student can use the hands-up facility if he wants to ask some questions or want to pass comments to instructor during session. He can use it to initiate conversation between him and the instructor.

- **Students’ (class) list**
  - In the instructor interface, there is a list of all students, which consists of the names of the students that registered the course and are on the live session. Instructor can eject any particular student using the eject facility available in the instructor interface.
  
  - In the student interface, the list will only show the names of fellow students that registered for the course and are on live session. No student on session can be ejected through the student interface.

- **Course Info**
  - In the instructor interface, there is a list of courses with details such as course title, credit units, status and lecture schedule (time of offering or presentation) arranged according to students’ level of study (NCE1, NCE2, NCE3). When the instructor logs in, he goes to choose level of student, course to present and click ‘Present’ to upload the presentation file if it is the scheduled time of presentation.
  
  - He can also alter the presentation time if he is the one assigned the course and then broadcast the new date/time to all class members.
  
  - In the student interface, the students can only view but cannot edit course information.

- **Collaborate**
  - In instructor and student interface after lecture session, communication channels are opened for text, audio and video messages.

  - In the instructor interface, an instructor is given the right to turn off this facility if he is not ready to interact with other users.

  - But in the student interface, the facility is permanently opened.
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 Windows 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.

WebVCS Interfaces:
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Conclusion

In this work we have successfully developed generally useable Web-based Virtual Classroom System (WebVCS) model that will provide a viable alternative to the traditional teaching/learning system in our tertiary institutions. Successful implementation of this system in our tertiary institutions will unarguably improve access to quality education and full adaptation of ICT in learning among our students. However, for optimum realization of the objectives of this research, certain measures have to be put in place - Internet facilities and computers should be made available even in remote communities; Collaborative efforts are required among institutions, development partners and various agencies of government saddled with the responsibility of managing the education system so as to produce a commercialized version of the WebVCS model.

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