A WEB-BASED VIRTUAL CLASSROOM SYSTEM MODEL

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ABSTRACT

The population of students all over the world is growing without a proportionate increase in teaching/learning resources/infrastructure. There is also much quest for learning in an environment that provides equal opportunities to all learners. The need to provide an equal opportunity learning environment that will hitherto improve the system of education globally has therefore become imperative. Based on our findings, a mathematical model Web-based Virtual Classroom system (WebVCS) was developed to provide a viable medium through which sound education can be offered in tertiary institutions that can carter for varieties of learners irrespective of their abilities, dispositions and geographical locations. Our system model is developed based on active learning approach that adopts blended learning theory (Constructivist-Cognivist learning approach), incorporating e-pedagogy that supports collaboration among participants in the web-based Virtual learning environment. The key objects used in creating the WebVCS model are: Courses, Students, Instructors and Learning performances. Our system model sets a framework for developers of virtual classrooms and successful implementation of the model leads to students learning by interacting with their peers resulting in the construction of knowledge.

INTRODUCTION

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 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.

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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.

Some students live in other parts of the country (Nigeria) or even in other countries, and some are gainfully employed, some are hospitalized due to illness and some are physically challenged. For all these persons distance education and web-based learning (e.g VCS) may offer interesting opportunities and democratic advantages. Hilz (1997) asserts that collaborative learning at a distance may give as good results as learning in a traditional classroom, or even better.

To overcome some of these limitations outlined above, we propose to develop a "Mathematical model Web-based Virtual Classroom system" based on active learning approach. Various virtual classroom systems exist quite alright, to date there is no standard framework or model to guide developers of such systems. Our model is therefore intended to provide the much needed framework for virtual classroom system developers. The task of this research is to examine current aspects of web-based learning environment (Virtual classrooms) in use and identify the areas for improvement and then overall goal being; to according to our requirements, develop a mathematical model web-based virtual classroom system (VCS) which will emerge as a viable tool through which collaborative learning and quality knowledge in various ways and approaches can be gained.

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 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.

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.
> Instructor's 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).
> No single system can be used to manage all the academic activities and records of students and entire classes throughout the entire academic programme (sub-degree, degree).

Our work is a mathematical model web-based virtual classroom system which is related in function to all the systems being examined and described above. 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.

WEBVCS FRAMEWORK MODELING

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 according to the following modalities: remote access for all system users; direct interaction between student and instructors/tutors; support to communication among students; possibility for students to work in cooperative way.The new webVCS is a composite structure with activities in it layered over information/learning resources. Contents in the WebVCS are acquired through harvesting of resources from the databases and the WebVCS database acquires data through manual input from instructors, students and administrators and focused searching and retrieval from the web.

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 communication and the virtual classroom system available to all classes of persons – physically challenged, the hospitalized, working class students and so on, irrespective of their geographical location.
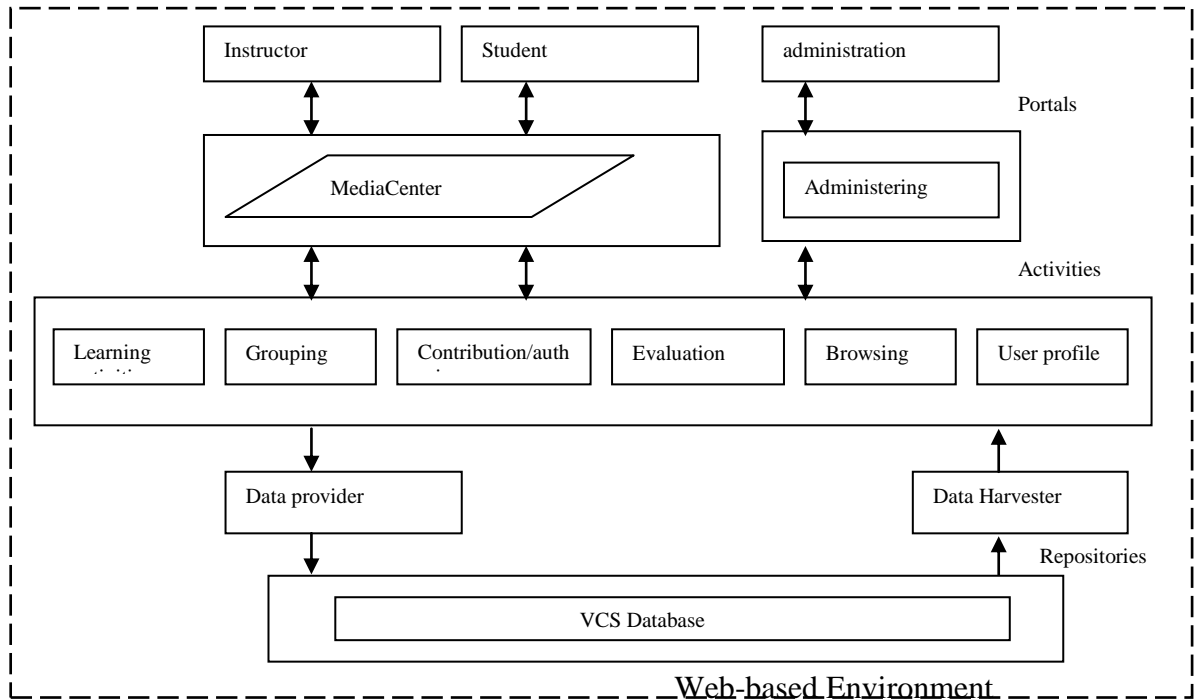

Fig.1: The WebVCS Architecture

The Webvcs Model Derivation

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

Let CO_{ik} be courses to be undertaken by the students where i = 1,2,3,...X (students' year of study) and k = 1,2,3, ... n (k is the course number registered for). Each course syllabus is split into topics (to$_ι$) and $ι$ = 1,2,3, ... t, the topics (to$_ι$) are in turn split into subtopics ($SO_{ιm}$) and m = 1,2,3, ... (lesson units or pages or screens)

Let S_j - represents the various students of the course CO_{ik} , j = 1,2,3, ...,N, I_k - represents the various instructors assigned to the courses CO_{ik} , Let P_{jk} – represents students' learning performance in course CO_{ik}. *tudent's Overall Learning Performance in the Web-based Virtual Classroom is given as:*

$$P_j = \sum_{i=1}^{X} \sum_{k=1}^{n} \sum_{j=1}^{N} W_j(g_{ik}(CO_{ik}, S_j) + \sum_{z=1}^{Z} G(A_{kz})) \ ... \ (1)$$

Where: $g_{ik}(CO_{ik}, S_j)$ = a function that returns student S_j's contribution or performance in collaborative/group studies in the course CO_{ik}

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

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

i = student's year of study (i = 1,2,3,.. X), k = courses registered (k = 1,2,3,......,n), n = total number of courses registered

j = students for the course CO_{ik} (j = 1,2,3,........,N), N = total number of students who registered for the course CO_{ik}

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

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

$$W(I_k) = \sum_{l=1}^{x} V_{lm}(SO_{lm}) \text{ .... (2)}$$

Where l = 1,2,3,........,x (course topics), k = courses registered
SO_{lm} = subtopics, m = 1,2,3,.....(lesson units or pages)
Then the Web-Based Virtual Classroom Mathematical Model is given as:

$$WebVCS = F(\sum_{j=1}^{N} P_j, \sum_{k=1}^{n} W(I_k)) \text{ .... (3)}$$

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 pages) 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_l) or subtopic (SO_{lm}) is presented to the student using a web page for efficient learning. The basic assumption of the WebVCS is that one or more to_l or SO_{lm} 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_{kz} (assessments): where z = 1,2,3,.. . 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_{k1}), assignments (A_{k2}), tests (A_{k3}), final examination (A_{k4}) and collaborative studies evaluation (g_{ik}), are employed. Each topic (to_l) or subtopic (SO_{lm}) is associated with a minimum time T_{lm} in which student S_j of various categories ought to have spent in the classroom to be able to learn properly topic (to_l) or subtopic (SO_{lm}). T_{lm} 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. W_d represents P_{jk} contributions to the overall WebVCS learning process such that

$$\sum_{d=1}^{n} Wd = 100\% \text{ ....(4)}$$

Overall Performance = $0\% \leq \sum_{d=1}^{n} W_d \sum_{z=1} P_{kz} \leq 100\%$ **. (5)**
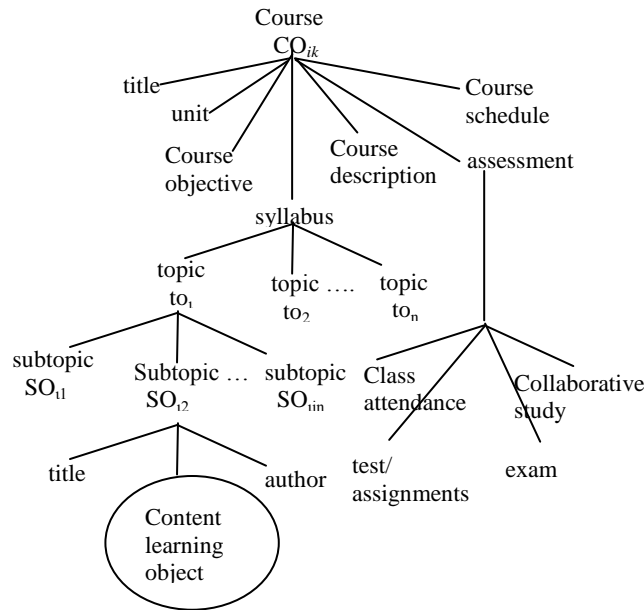

Fig.2: Course Tree Structure (Adapted from Adewale, 2007)

Students' Level of Participation

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

$$\mathbf{A_{k1}} = \frac{1}{n} \sum_{l=1}^{n} T_{lm}(SO_{lm}) \; \dots\dots\dots\dots\dots\dots \textbf{(6)}$$

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

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_{ik}). 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:

$$\mathbf{P_k} = \sum_{z=1} G(A_{kz}) \; \dots\dots\dots \textbf{(7)} \text{ , Where G is a function that returns the score associated with } \mathbf{A_{kz}.}$$

Collaborative Study Assessment

Let students S_j be the ones that registered for the course CO_{ik}. 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} = groups, q = 1,2,3, ... gp

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

$$P_k = W(g_{iq}(CO_{ik}, S_j)) \text{.................(6)}$$

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_{ik}). Each topic (to_l) or subtopic (SO_{lm}) is associated with minimum time V_{lm} in which the instructor I_k of the course CO_{ik} 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:

$$I_k = \frac{1}{n}\sum_{l=1}^{n} V_{lm}(SO_{lm}) \text{ .... (8)}$$

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

For example, for the first student j = 1 in year1, his overall Learning Performance (P_j) in the Web-based Virtual Classroom is given as:

$$P_1 = W_1(g_{11}(CO_{11}, S_1) + \sum_{z=1} G(A_{1z}) + g_{12}(CO_{12}, S_1) + \sum_{z=1} G(A_{2z}) + g_{13}(CO_{13}, S_1) + \sum_{z=1} G(A_{3z})$$
$$+ \text{.........} g_{in}(CO_{in}, S_N) + \sum_{z=1} G(A_{nZ}))$$

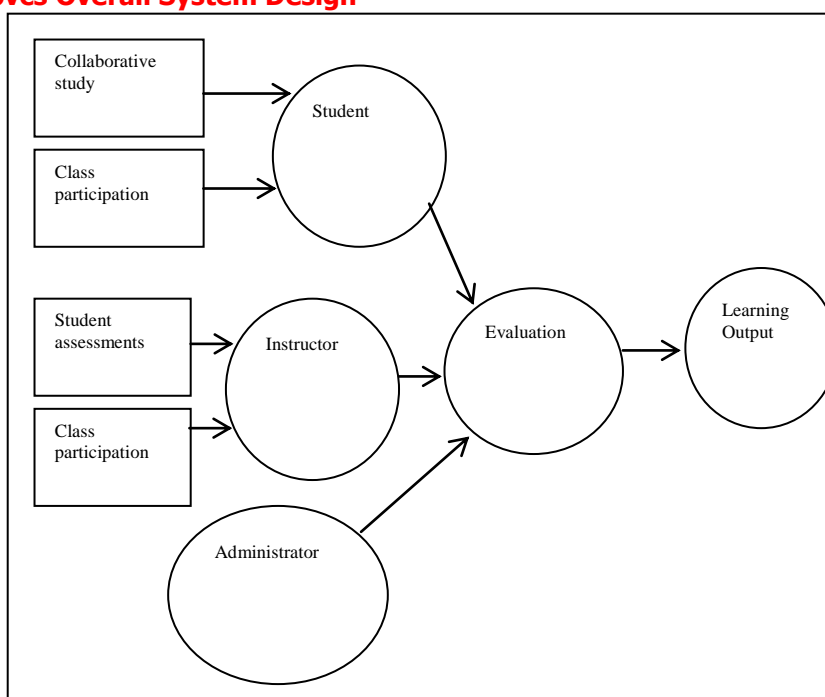**The Webvcs Overall System Design**

Fig.3: WebVCS Overall System Structure

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.
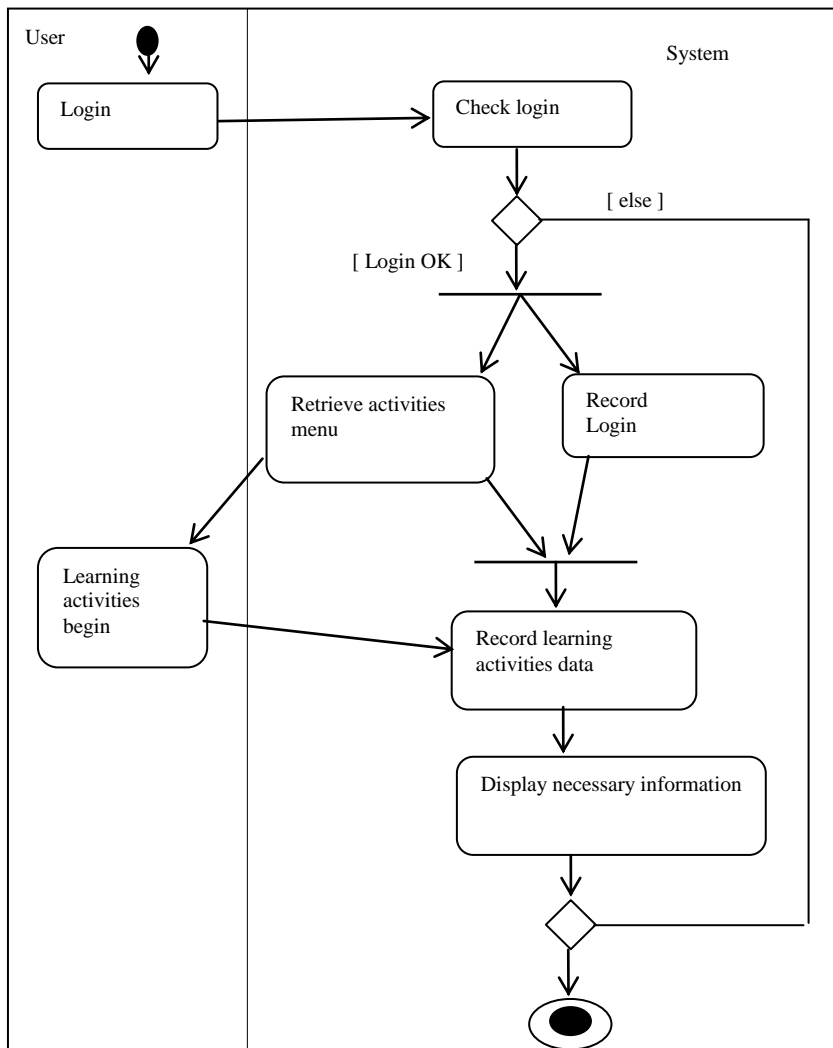
Fig.4: Activities diagram of WebVCS

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.
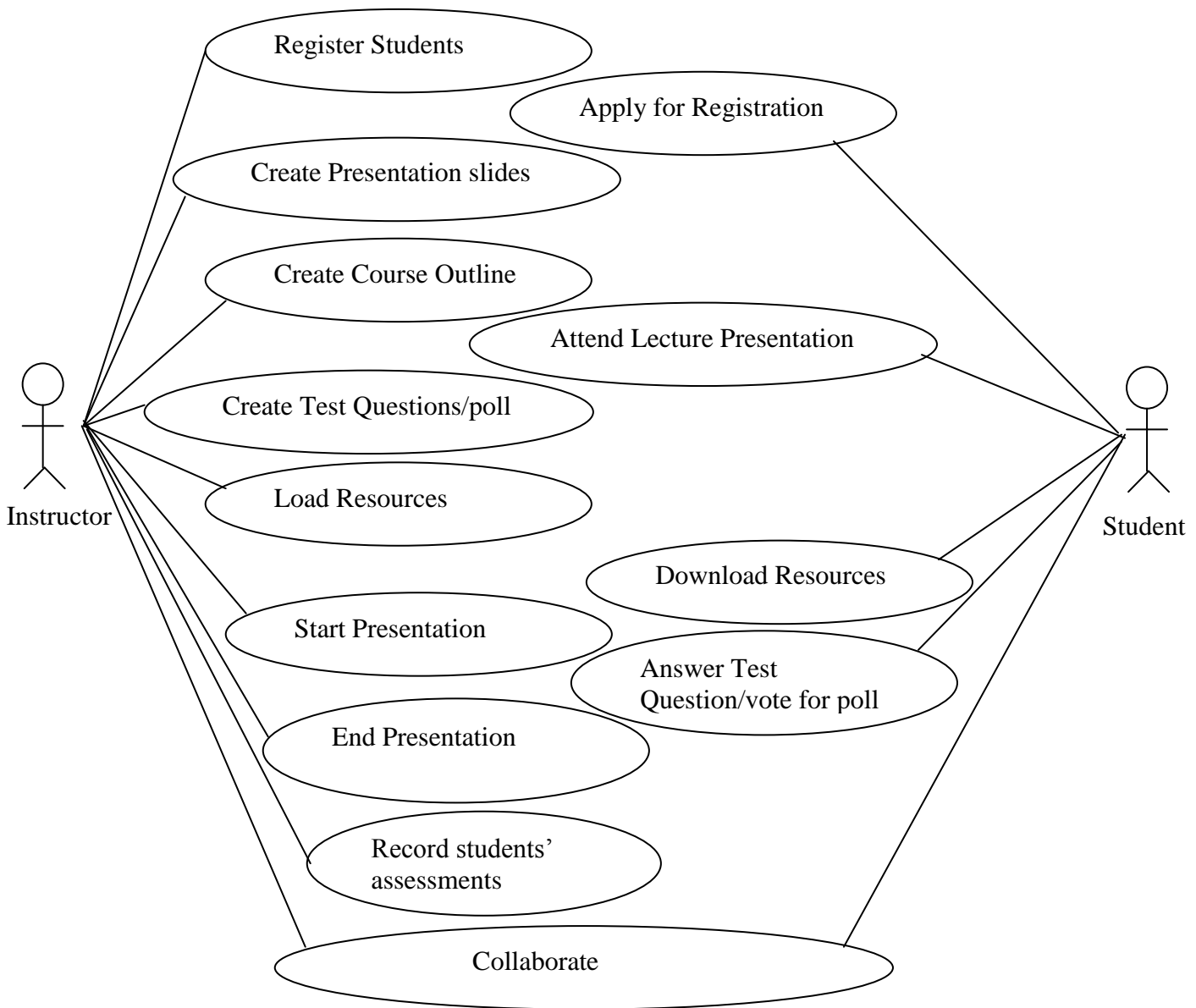
Figure: 5
Use Case Diagram for Web-based Virtual Classroom

In the use case diagram of the web-based virtual classroom above, there are two entities – Instructor and Student, who interact with the system. These two entities are the actors in the system. Activities performed by the Instructor and student are clearly illustrated.

The Class diagram below gives a pictorial representation of the detailed system design.
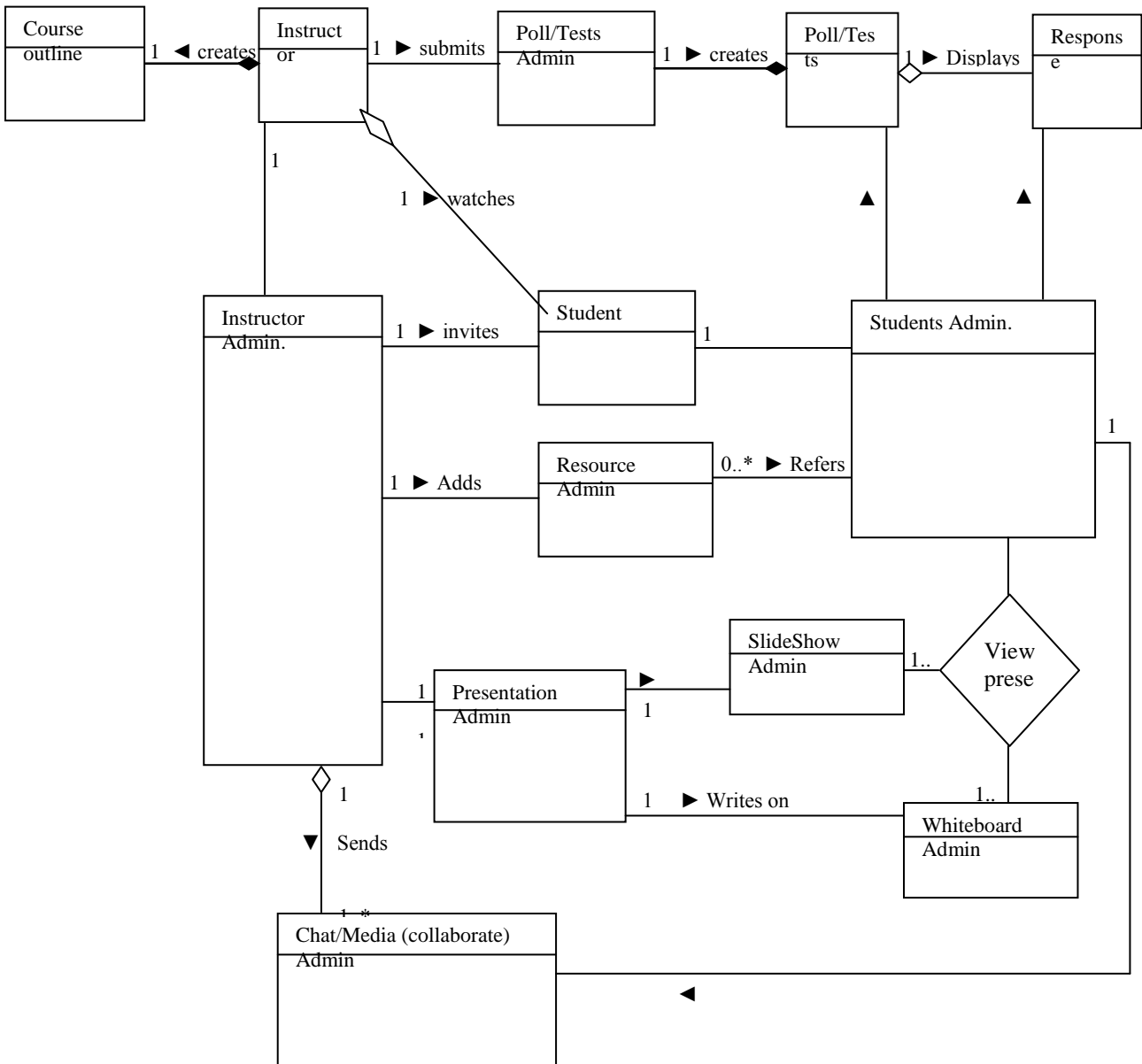
Fig.6: Class diagram for Web-based Virtual Classroom

CONCLUSION

This research has successfully produced a customized Web-based Virtual Classroom System (WebVCS) model that will provide a viable alternative to the traditional teaching/learning system. A successful implementation of this research will improve access to quality education. 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; 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 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 221 system.

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REFERENCE

Adewale, O. S. (2007). *University Digital Libraries: Adaptive, Personalised E-Learning System.* Yerimah Prints, Nigeria.

Atasi, M. and Madanmohan, S. (2008). *Learning Through Virtual Classroom.* Accessed at http://www.aiaer.net/ejournal/Vol19207/24.Atasi_Madan.htm

Bernie, D. (2008). *Some Thoughts About WebQuests.* Accessed at http://edweb.sdsu.edu/courses/edtec596/about_webquests.html. on December 22, 2008.

Carina, A. and Rune, P. (2002). *Design of a Virtual Classroom.* A paper presented at the 34th Annual onference of the International Visual Literacy association. Breckenridge, Colorado, U.S.A, October 1 − 5.

Elizabeth, N., Jason, G., Jeremy, S.(2005). *Beginning   PHP5, Apache and MySQL WebDevelopment.* Wiley Publishing Inc, U.S.A.

Paratone, J.R. and McCormack, R.L.(eds.) (1997). *Peer Talk in the Classroom: Learning from Research.* International Reading Association Inc., U.S.A.

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Strasser, S.E. (1993, November). *E-mail Minutes: In Answer to the One-Minute Paper.* Proceedings of the 1993 Annual Meeting Decision Science Institute, Washington, D.C. 290 − 292.

Zhao, J.L. and Kanji, A. (2008). *Modeling and System Design for Web-based Collaborative Learning.* Accessed at: http://www.eecs.kumamoto-u.ac.jp/ITHET01/proc/084.pdf

Zongkai, Y. and Quingtang, L. (2007, February). *Research and Development of Web-based Virtual Online Classroom.* ScienceDirect − Computer & Education, Vol.48, Issue 2, pp 171 − 184.