DEVELOPMENT OF AN E-LEARNING WEB PORTAL:
The Foss Approach

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ABSTRACT

With the vast development of various technologies, learning today is no longer confined to classrooms with lecture delivery as the only method of conveying knowledge, rather, an electronic means of learning has continued to evolve. Electronic learning (e-Learning), which facilitates education using communications networks, has made learning possible from anywhere at anytime using the Internet, wide area networks or local area networks. Notably, e-Learning applications which have now become central to the learning process may be developed using proprietary programming tools and the process of acquiring and using them to develop large software application is not only complex but require a huge sum of money. A viable alternative is to utilize the open source software platform that allows software engineers and institutions the right to reuse, study, distribute and localize to satisfy user's requirements.

This paper provides an overview of e-Learning and the open source domain as well as discusses how open source can be used to speedily realizes the development of an e-Learning application in a web environment using an adaptive process. Specifically, the authors described their preliminary experiment of implementing an open source e-Learning platform by adapting free PHP source code and MySQL database to suit an electronic class bulletin board.

Keywords: e-Learning; Open Source Software; education; intranet; internet; ICT; CMS; e-Bulletin board and web.

BACKGROUND INFORMATION

Open Source Software (OSS) is software that is made available along with source code at no cost. The freedom to use, study, redistribute and modify the software to suit user's needs is granted to the consumers. The following are among other benefits open source model can offer (Siemens, 2003): "increased quality, greater stability, reduced costs, reliability and rapid fixes to bugs/problems". In contrast, proprietary software is licensed to users for a fee and the source code is usually closely guarded and not made available to the public (Olorunfemi & Oladipo, 2005).

It is illegal to make copies, adapt or distribute proprietary software without paying additional licensing fees. Notably, the term Open Source Software (OSS) and Free and Open Source Software (FOSS) mean the same thing and are used interchangeably.
Open Source and E-Learning

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OSS is software whose source code is published and made available to the public, enabling anyone to copy, modify and redistribute the source code without paying royalties or fees[3].

Some examples of open source projects are Linux (http://www.linux.org), Apache (http://www.apache.org), Mozilla (http://www.mozilla.org), and OpenOffice (http://www.openoffice.org). The GNU acronym for "GNU's Not Unix" project (http://www.gnu.org) defines free software as user's freedom to run, study, distribute, change and improve the software. More precisely, it refers to four kinds of freedom, for the users of the software:

> - the freedom to run the program, for any purpose,
> - the freedom to study how the program works, and adapt it to ones needs,
> - the freedom to redistribute copies, (iv) the freedom to improve the program, and release the improvements to the public, so that the whole community benefits.

Open source provides users with access to a worldwide development community that improves, adapts and fixes the software often much faster than in the proprietary vendor world. Open source does not tie users down to any particular vendor for software updates, patches, fixes and enhancement.

In contrast, open source may not be more advantageous than proprietary software, and may not be necessarily excellent in all situations, after all, it is not appropriate for every situation and may not be able to displace proprietary software over night (Gustafson, 2004).

Open source software is certainly one of the most important and relevant software trends of this decade. The success of Linux and Apache is pushing practitioners and researchers to reconsider some of the classic assumptions about software development. Even software giants such as Microsoft, SUN and IBM have been changing or adapting their strategy to take into account this alternative approach.

It has been claimed by free and open software advocates such as Richard Stallman that software must be "free" as in "free speech" because proprietary/close software violates some basic users' rights which include the freedom to use, study, redistribute and adapt the software (Fuggetta, 2004).

The Open Source Initiative (OSI), a non-profit marking organization that initiated open source (see http://www.opensource.org) that was formed to educate on the benefits of open source, stated that, Open Source does not just mean access to the source code, rather, the distribution terms of open source software must comply with the following criteria:

> - Free redistribution, source code must be included,
> - derived works – allow modifications,
> - integrity of the author's source code,
> - no discrimination against persons or groups,
> - no discrimination against fields of endeavor,
> - distribution of license, vii) license must not be specific to a product,
> - license must not restrict other software and ix) license must be technology-neutral.

The following are some of the benefits of using open source in the educational environment (Tong, 2004):

> cost, ii) reliability,
> performance,
> security,
> build long term capacity,
> open philosophy,
> encourage innovations,
> alternative to illegal copying,
> possibility of localization, and
> learning from source code.

Description of some notable open source software:

Hypertext Preprocessor (PHP)

PHP is the web development language written by and for web developers. PHP stands for Hypertext Preprocessor. It is a robust, server-side, open source scripting language that is extremely flexible and very easy to learn.

PHP is also cross platform which means that PHP scripts will run on UNIX, Linux, Windows NT server and now Mac OS (Why PHP, 2004). In (Linux. n.d.), PHP is defined as an official module of Apache HTTP server, the market-leading free web server that runs about 67 percent of the web servers.

MySQL

MySQL (pronounced My SEE Q EL) is one of the standard query languages for interacting with databases. MySQL is an open source database server that is free and extremely fast. MySQL is also cross platform and it has a high customer base for its flexible licensing terms, ease of use and high performance.

Its acceptance was aided in part by the wide variety of other technologies such as PHP, Java and Perl (Linux. n.d.).

Apache

Apache is the most popular of all the web servers available because it supplies basic web server functionalities (Linux Web Solutions, 2000).

A survey conducted by Forrester Research Inc, titled "your open source strategy" in September 2003 shows that Linux and Apache are the two leading open source software (Gustafson, 2004). This trend has been maintained till date.

The survey involves 50 Information Technology (IT) managers and executives at $1Billion+ investment North American companies (see figure: 1).

Similarly, in a study conducted by Netscraft, on the market share for top servers across all domains, Apache leads because it runs nearly 70 percent of the world's web sites in a survey of over 50 million web sites (Gustafson, 2004).
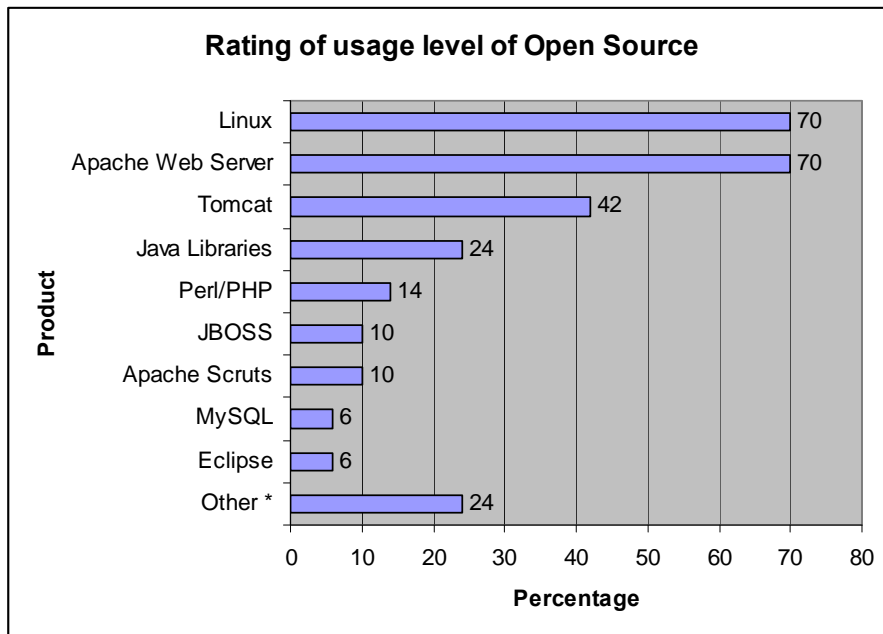
Figure: 1.
Rating of usage level of open source.
Source: (Forrester Research Inc., 2003)

Linux

Linux is one of the most popular open source server operating systems. It does not require user licenses, so it is economically accessible for many institutions and individuals who cannot afford proprietary software.

The combination of PHP and MySQL form the most widely used open source scripting language and database on the web today. They are the world's best combination for creating data-driven sites (Merrall, 2005). In (Tong, 2004), the choice of PHP and MySQL is based on:

> - **Cost,**
> - **ii) ease of use,**
> - **iii) HTML embeddedness,**
> - **iv) Cross − Platform Compatibility,**
> - **v) Not tag-based,**
> - **vi) Stability,**
> - **vii) speed,**
> - **viii) flexible open source licensing,**
> - **ix) fast feature development,**
> - **x) not proprietary, and xi) strong user community.**

Components of an E-Learning Web Portal

The term learning means "to gain knowledge or understanding of or skill by study, instruction or experience". Unfortunately e-Learning does not possess such a precise and clear definition. The understanding of the e-Learning concept varies from "training via the Internet" according to (Computer User High-Tech Dictionary, http://www.computeruser.com), to a more extended definition as "an approach to 189

facilitate and enhance learning by means of personal computers, CDROMs and the Internet" as explained in (Wikipedia, the free encyclopedia, http://en.wikipedia.org). E-Learning is the delivery of education (all activities relevant to instructing, teaching, and learning) through various electronic media (Koohang & Harman, 2005). The electronic medium could be the Internet, intranets, extranets, satellite TV, video/audio tape, and/or CD ROM.

An e-Learning web portal is able to provide students with network access to information covering all learning resources and services available to them. Typical e-Learning portal features contain one or more of the following components (Volodymyr & Wilfried, 2004): organization, information, documentation, assessment and communication.

An e-Learning platform is a specialised software, sometimes referred to as the virtual learning environment or the Course Management System (CMS). This software should be capable of providing facilities for both the development and the delivery of e-Learning services. The CMS is usually a distributed online system connected to the Internet through the e-Learning web portal. Several communications media are used for e-Learning including the Internet, Intranets, extranets, video/audio tape, and/or CD ROM. From history, some educational institutions have started the process of creation of enterprise open source applications such as course management systems and electronic bulletin (e-bulletin) board. These are some of the initiatives taken by higher institutions to move away from proprietary software towards open source.

The rest of the paper is organized as follows. Section 2 discusses some of the researches that relates to the work described in this paper. Section 3 presents the statement of problem. The objectives and methodology of the research is presented in section 4 and 5 respectively. Section 6 describes the architectural framework of the system. The existing and proposed systems were considered. Section 7 contains the concluding remarks.

REVIEW OF RELATED LITERATURE

A number of e-Learning systems related to this work have been reported in literature. Some of them address e-Learning using commercial products that are proprietary in nature, while some others are based on free and open source software. An approach for evaluating e-Learning applications as well as a conceptual framework of open source software is contained in some other literature.

In (Koohang & Harman, 2005), open source tools as vehicle for e-Learning was examined. It recommended that the use of open source as a vehicle for e-Learning be further explored in three areas: instructional practices, instructional platforms and instructional philosophy.

The European Union (EU) funded Edukalibre project was reported by Botturi et al. (2005). At least two web-based simple document management tool called COLLAB (COLLABorative effort), and a groupware tool called COnDOR (Construction of Dynamic Open Resources) has been created through this project as a module of the open source Moodle (see http://moodle.org).

Moreover, a visual user-tracking tool was developed, again for the Moodle environment, called Graphical Interactive Student Monitoring System for Moodle (GISMO) (Mazza & Botturi, 2007).

The main activity of the Edukalibre project is the translation of the uses and procedures of libre software (free/open source software) to the creation of content suitable to be used as material for education. This includes the implementation and evaluation of suitable tools, and the creation of some materials among all the partners (see http://edukalibre.org/about). It is expected that the tools developed will facilitate the collaborative construction of educational resources by both teachers and students. The project involves developers and educationalists from several European countries working together to study both technological and educational aspects of the successful deployment of the open development model in university teaching. The paper also proposed an evaluation approach for e-Learning systems that follow the Open Development Model(ODM). It was argued that such an evaluation approach would have to be holistic in the sense that it offers feedback from users beyond issues of usability.

An article by Machado & Thompson (2005), outlines the development and proliferation of Open Source Software (OSS) within the sphere of education. It discusses the reasons for the acceptance and spread of OSS in Higher Educational Institutes (HEIs) across Europe, outlining its role within the four key domains of higher education (Economical, Technological, Pedagogical and Philosophical). Finally, the article illustrates the case of a current Tempus Project in Central Asia, for which Open Source-based virtual learning environments (VLEs) have provided support for the delivery of a convergent curriculum across several HEIs in Central Asia. An evaluation of open source e-Learning platforms with the aim of finding the platform most suitable for extending to an adaptive one was presented in (Graf & List, 2005). The result of evaluation showed that the platform *Moodle* outperforms all other open source e-Learning platforms (such as Dokeos, dotLRN, ILIAS, LON-CAPA, OpenUSS, etc) and obtained the best rating on factors affecting adaptability. An article by Dagger et al. (2007) illustrated and discussed the evolution of Learning Management Systems (LMS). It was mentioned that LMS as an e-Learning platform provide a suite of tools which support the creation, maintenance and delivery of online courses; the enrolment and management of students; the administration of education and the reporting of student performance. LMSs can be grouped into two main categories;

> - open source initiatives such as Moodle (http://www.moodle.org), SAKAI (http://sakaiproject.org), ATutor (http://www.atutor.ca) and Whiteboard (http://whiteboard.sourceforge.net) and
> - proprietary solutions such as WebCT/Blackboard (http://www.blackboard.com), Gradepoint (http://www.gradepoint.net), Desire2Learn (http://www.desire2learn.com) and Learn.com (http://learn.com).

Open source LMSs are typically built upon extendable frameworks allowing implementers to adjust and modify the LMS to suit their specific needs. This approach, although traditionally not adopted by the proprietary sector, is emerging through such initiatives as WebCT's PowerLinks kit and Blackboard's Building Blocks. The article also highlights on a set of core challenges to be addressed in order to achieve information interoperability in next-generation e-Learning platforms.

In (Fuggetta, 2004), some considerations about the claims and expectations associated with OSS were presented. The goal was not to deny the roles and opportunities associated with OSS. Rather, it aims at identifying the real and novel characteristics of OSS in order to effectively exploit them.

It also proposed some reflections that aim at critically revising some assumptions about open source software. An approach to help policy-makers and decision makers understand the potential use of Free and Open Source Software (FOSS) in education – where and how it can be used, why it should be used, and what issues are involved were discussed by Tong (2004). In (Botella et al., 2006), the features of student-lecturer interaction in e-Learning were presented along with the result of an opinion poll to determine the perception of e-Learning to students of higher education.

The approach presented in this work regarding e-Learning application derives from the adaptation of free open source code to suit a basic electronic class bulletin board system. The adapted code is free and made available through the web site to reduce cost and time and enhance speed of development.

STATEMENTS OF THE PROBLEM

Electronic learning (e-Learning), which facilitates education using communications networks, has made learning possible from anywhere at anytime by using the Internet, wide area networks or local area networks. Notably, e-Learning applications which have become central to the learning process may be developed using proprietary programming tools. Meanwhile, the process of acquiring proprietary programming tools, the license and using them to develop large software application is not only complex but a huge sum of money is spent on the purchase and license. These have also affected the widespread and the level of usage of the system. A possible solution to these problems is to utilize highly flexible open source application that allows software engineers and institutions the right to reuse, study, distribute and localize the codes to satisfy user's requirements.

OBJECTIVES OF THE RESEARCH

The objectives of this paper are as follows: i.) to introduce members of the academics to the concept of e-Learning, online learning and virtual learning based on OSS, ii.) to foster better and cordial interaction among members of the academic community(staff and students), and iii.) to develop a cost effective and efficient system(almost free) for disseminating educational resources between the students and lecturers.

RESEARCH METHODS

The methodology adopted in developing the e-Learning system is two-fold: First, download the free e-Learning open source software (PHPBB) on the Internet. Second, expand and adapt the FOSS to satisfy local environment. The system was developed using tools such as: PHP as Front-end, Apache as Middle-ware and MySQL Database as Back-end.

ARCHITECTURAL FRAMEWORK OF THE SYSTEM
The Existing System
The open source community developed some PHP source code which can be adapted to suit different purposes ranging from collaborative systems, e-Learning systems, community interaction systems etc. The code is available for download on the web site www.phpbb.com. Its development was accomplished through community efforts to support interaction and e-Learning among members of the communities, using an electronic class bulletin board system.

The application is a virtual interactive communication environment and it has the standard tools included in most e-Learning/interactive platforms such as member registration, forums, sending and receiving of messages to members, help facility using Frequently Asked Questions(FAQ), search, memberlist, user groups and user's profile. Figure: 2 shows the main menu of the existing system after download and installation.
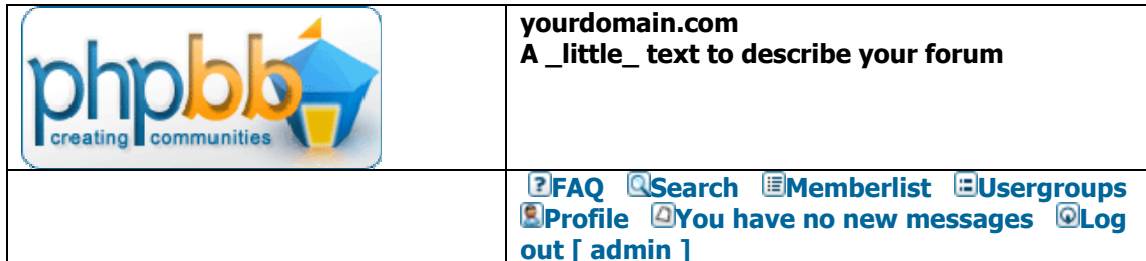
phpbb creating communities	**yourdomain.com** **A _little_ text to describe your forum**
	?**FAQ** Q**Search** ≡**Memberlist** ⊞**Usergroups** 👤**Profile** ⌂**You have no new messages** ⊚**Log out [admin]**

Figure: 2
The Home page of the existing system. Source: www.phpbb.com

The Proposed System and Its Implementation

The modified version of the e-Learning application contains the following added components (indicated by the broken line boxes in figure: 3).

- ➢ **Home- to move to the index page.**
- ➢ **Chat- navigates to chat room for communicating with registered members of the e-Learning community.**
- ➢ **File attachment to the message (email) section- used to send messages and attach files.The institutional logo on top left and top right of all the pages of the board as well as forum name, type and category were also customized.**
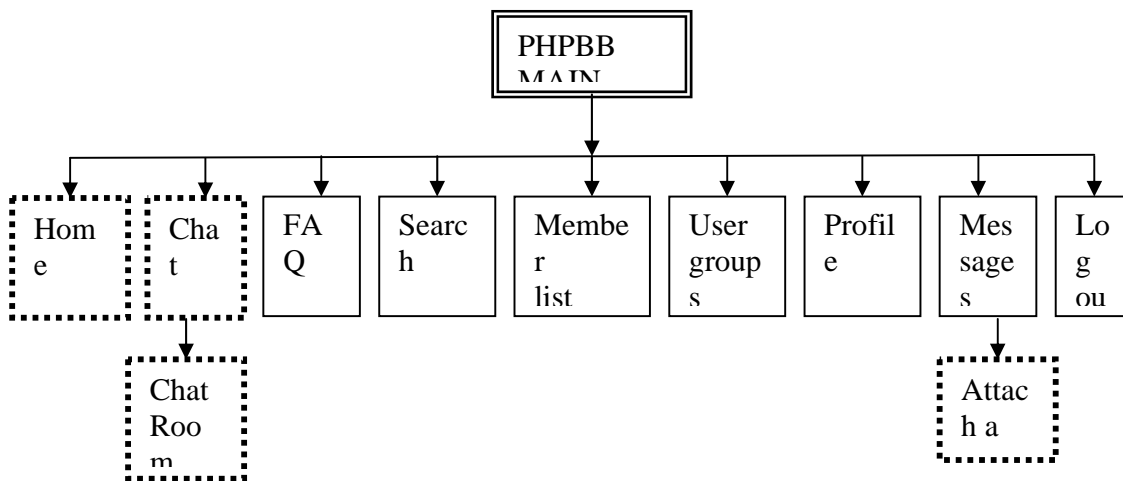

Figure : 3
Overview of the expanded system
N.B. Broken line boxes indicates the expanded/added components

Figure: 4
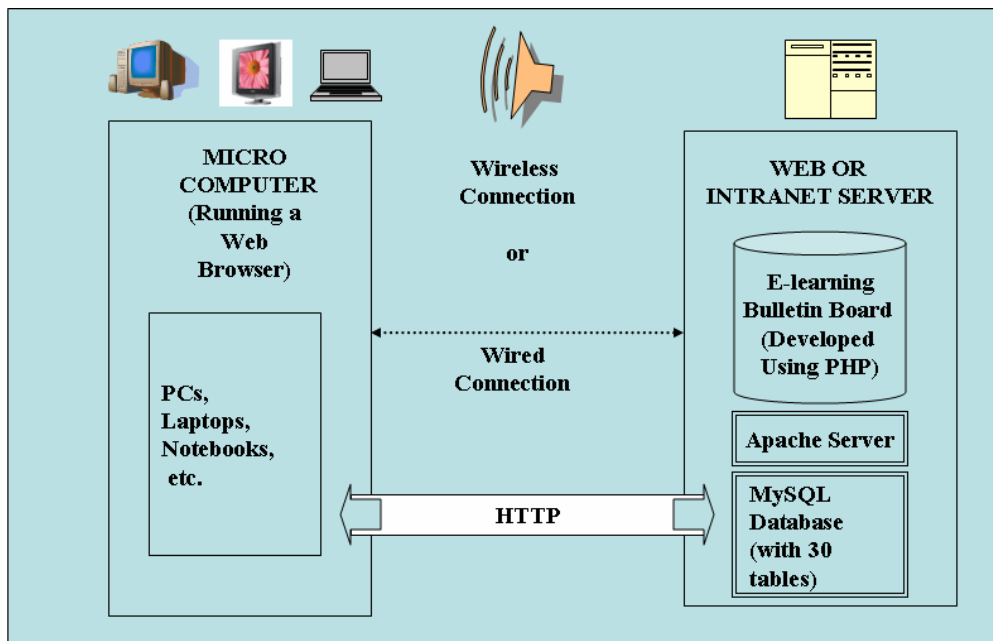**Architecture of the proposed e-Learning**
Open Source class bulletin board

The proposed open source e-Learning system is based on client/server architecture as shown in Figure: 4. The communication media between the client and the server may either be wireless or wired using the Internet or intranet. The clients of the e-Learning class bulletin board system may use microcomputer devices (such as PC, notebook or Laptop, etc) to communicate with the server and with each other. Once a user successfully login, all the e-Learning resources will be made available with a display of the name of the user that logged in.

Two additional tables were added to the existing tables in the MySQL database to raise the total number of tables in the existing system from thirty to thirty two. The expanded system runs on MS Windows 95 operating system or higher version. The steps to download, install and localize phpBB2 application on a local server are discussed as follows:

> ➢ Download phpBB2 files/folders from **www.phpBB.com** web site and copy to
>> ➢ the localhost path in the local disk. Ensure that PHP, Apache, PHPMyAdmin and
>> ➢ MySQL are installed and running in your computer.
> ➢ Enter **http://localhost/phpmyadmin** to create a database, and **http://localhost/phpbb2/install/install.php** on the URL address of your web browser. A message "Welcome to phpBB2 installation" will appear.
> ➢ Fill out the details required on the form and click on start install. Note that the database name entered should already exist as specified in ii. above. Another screen will appear.
> ➢ Click on finish installation to view the login home page of the installed phpbb files

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- Ensure you delete the folders/install and /contrib from the **http://localhost/phpBB2** path before you continue.
- To enter the home page, simply type **http://localhost/phpBB2** on the URL of your browser. A username and password is required to log into the phpBB2 application.
- The modification of the files is done in c:/localhost/phpBB2 directory and previewed using **http://localhost/phpBB2** on the URL.
- The sub menu *Register* makes provision for ordinary users to register their profile with a unique username and password to allow successful login. Administrative users will need to log in with admin username and admin password (created during installation) for the link "Go to Administration Panel" to display. Clicking on "Go to Administration Panel" will take you to the Administration section where Forum, Backup, User and Statistical information, etc are managed, controlled and monitored.

To run the application from the Internet, the modified files will have to be uploaded to a web server running Apache/MySQL and accessed through a browser from a micro-computer client. The same approach is used for running on an intranet, except that the modified files are uploaded to an intranet Server running Apache/MySQL. Figure: 5 shows the main menu of the expanded system after installation and modification with an additional *Home* and *Chat* sub menu, and *attachment* sub menu contained in message menu.
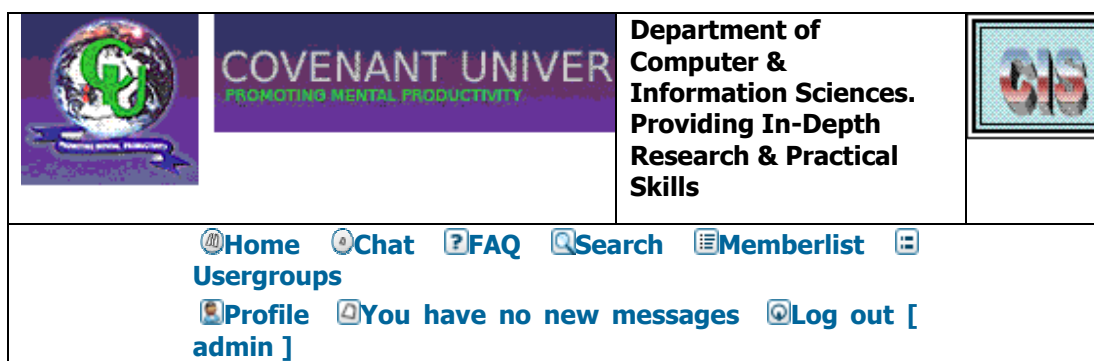

Figure: 5
The Home page of the expanded system

CONCLUSION

The authors have developed an e-Learning class bulletin board that facilitates virtual interaction of students and lecturer in an academic environment. This work is unique and makes special contributions to knowledge in terms of developing an e-Learning class bulletin board through the use of FOSS, it also adds some components (Home, Chat and Attachment) to the original source code downloaded from the Internet.

It may be possible for other Content Management Systems (CMS) to achieve some of the functionalities similar to what obtained in the developed e-Learning application. The authors' primary objective is premised on flexibility, cost and speed of development of e-Learning system through adaptation of ready available open source code, particularly when compared with attempting to achieve the same result using proprietary programming tools.

Furthermore, it can be concluded that: i) open source is the future for e-Learning solution, particularly, in developing economies, ii) functional education can be driven by e-Learning assisted open source systems, and iii) with open source, less effort is required for developing e-Learning application.

With the emergence of ICT and most specifically Free and Open Source Software, learning institutions are beginning to witness a considerable impact of technology in education. Thus, the paper succeeded in introducing members of the academic community to e-Learning, online learning and virtual leaning. The authors have also provided a system that will foster better and cordial interaction among members of the academic community.

A cost effective system, which is almost free, for disseminating educational resources between the students and lecturers was developed.

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