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Step by Step Guide to Implementing LMS with Live Teaching

Case study: eVarsit.net

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Abstract

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<p>Nearly 100 percent of Finnish educational institutes offer some form of online studies from high school level to higher institutes. These platforms are given fancy names such as Wilma by Eira High School or Tuubi by Metropolia. Some institutes move further to offer full courses online called Virtual Open University where prospective students can accumulate credits online to prepare them towards a degree or diploma course. Degree students are also able to enroll with permission to gain some extra credits online.</p> <p>Using already existing LMSs students are able to access static resources in the form of recorded videos, audios or PDF files pre-uploaded as course contents to the sites. Students are able to communicate with the lecturers via chats, emails or messaging through the online Learning Management System (LMS). However, collaboration does not happen in real time therefore more students are likely to get bored along the way and drop out of the course entirely if they feel a teacher delays in responding to their questions or the course is too abstract to them and they cannot seem to get the explanation from reading the materials.</p> <p>The goal of this project is to produce a near experience to the conventional style of teaching by bringing live web conferencing together with LMS. Two separate LMS and a web conferencing servers shall be installed. The web conferencing server shall be integrated into the LMS. Students shall be able to watch and hear a live lecture by a lecturer who can navigate presentation files, write on a whiteboard for all the students to see in real time. Everything happens in a web browser and it is completely cloud-based. Nothing to download on install on the client PCs of the teacher or students.</p>	
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1 Introduction

1.1 Motivation

Technology is fast advancing and competence at work or acquiring the necessary skills to meet the job market has become paramount. There is always the need to keep one updated on latest growing trends in their fields. Timely scheduled training and upgrades have become more necessary now than before. Especially in the field of IT tons of frameworks, technology advances or Programming Languages evolve from time to time within a short time frame. Normally, subject enthusiasts will go online to gather snippets of these pieces of information to gain the necessary knowledge. However, with the invention of Learning Management Systems (LMS) these resources can be gathered and structured to be available for updates anywhere and anytime. This has generated a lot of interest from others who just want to acquire a new skill or improve upon their knowledge.

There is the new rush for online education entirely but I noticed a growing trend that even though several people enroll to take a course online the number falls drastically as the course progresses. Could it be that the students get bored along the way or their plans change with time, or perhaps the courses are not interactive enough?

What if live tuition is introduced into these online courses? Although, a plethora of web conferencing software have existed on the market for a long time it has always been used exclusively for business purposes such as for online business meetings or for webinars.

My goal in this bachelor's report is to merge web conferencing technology with a Massive Open Online Course (MOOC) using a Learning Management System (LMS) in the sense that teachers will be able to give scheduled live lectures to their students online.

1.2 Approach

An open source Learning Management System (LMS) called Moodle was use to set up a virtual university called e-Varsity. E-Varsity shall seek to present an opportunity to pro-

spective students in all nations across the globe access to the quality education in Finland. Students will not need to relocate to Finland during their studies since the preliminary coursework can be done online.

E-Varsity lectures will be live, that is, making a live streaming of lessons available to students across the world over the internet. Students shall be able to watch the lectures across multiple devices including PC/Mac, tablets, and mobile phones.

Lectures will be interactive in the sense that a course's participants will be able to see and hear the teacher speak, chat live with other participants and the lecturer as well. Students can raise their hands using emoticons to draw attention to speak. Students can be assigned roles to give presentations just as in physical classrooms and even answer quick polls set by the teacher during a live lecture online.

The lecturer can be able to set assignments of various types from pop-quizzes to research standard assignments. The assignments can be time bound or targeted to specific student pool set.

The scope of this bachelor's thesis project is limited to the following:

- Setup of a virtual MOOC website called e-Varsity using Moodle LMS.
- Setup of a live web conferencing server using the free open source BigBlue-Button on Ubuntu 1404 dedicated virtual server.
- The live streaming service was integrated with the LMS.
- The connection shall be demonstrated through testing to ensure everything works as expected.
- User experiences with the platform was tested.

2 eLearning: Theory

eLearning basically refers to learning through the electronic media, usually using the internet. The success of any eLearning process depends entirely on how the student motivates himself/herself. eLearning is conducted through the use of Learning Management Systems (LMS).

It is important to note how Learning Management Systems (LMS) through MOOCs is a game changer positively and why there is the need to pay more attention to it. It can rightly be stated that nearly 100 percent of degree-granting institutions in Finland offer online aspects of education as a form of a complement of resources.

2.1 Learning Management System (LMS)

2.1.1 What is Learning Management System?

A Learning Management System (LMS) is simply the software application behind the documentation, administration, scoring, reporting and delivery of educational content via the internet or intranet. It can as well be used for training purposes. Most corporate agencies have lately adopted to train their professionals using LMS to reduce the cost of training. [9.]

2.1.2 Common Features of Learning Management Systems

It should be noted that LMSs have evolved over the years since its inception. Some educational institutes such as the early developers and early adopter institutes in 2004 namely Stanford University, The University of Michigan, Massachusetts Institute of Technology (MIT), Indiana University, University of California, Berkeley and Foothill Community College all the USA built the Sakai LMS as a compelling alternative to proprietary learning systems. The Sakai project was initially funded by a grant from the Mello Foundation. Their goal was to come together to combine and synchronize all their various learning software into one integrated open source tool. It was not until 2005 that Sakai became a free software and its codes released for a more community driven advancement and development. The Sakai project today now a project of the Aspero Foundation has been translated into twenty plus (20+) languages and dialects, serving over 4 million students worldwide. [11.]

Many companies, on the other hand, have purchased, developed and rebranded LMSs to suit their in-house training models and only provide limited to no access. This is a regular occurrence however LMS generally bear some resemblance no matter how it comes about, whether in the corporate world or in education [8]. Some of these features include:

Social learning.

LMSs have and are still integrating social features such as Facebook to augment the process of learning. Often groups are created on social networks and linked to the LMSs to bring together like minds to share ideas, fraternize and develop together. Chatting, messaging, blogging and commenting on forum topics related to subjects are encouraged amongst participants of a course on an LMS. This idea is to increase the communications and collaboration amongst students by improving their social and networking abilities.

Software as a Service (SaaS)

As stated earlier, several companies have adopted LMSs built internally for the purposes of training and/or updating their professionals. These are usually behind firewalls and may not be accessible by the public.

They may include tools for talent management, that is, recruiting, tracking performance, compensations or befitting benefits or even serve as a guide to advise on whether some workforces should be succeeded or retained.

Virtual Classrooms

The early idea of an LMS was to augment the traditional style of teaching in most cases. The goal is to provide an experience that does not detach the students from the learning process. Therefore, some LMSs integrate with third party virtual classrooms such as web conferencing software, webinars, podcasts amongst others.

eLearning and Content Management

Ultimately the main reason for building an LMS is to provide education through the internet or an electronic means. This is what is termed e-learning. For e-learning to be effective LMS must provide the tools to manage contents of a course, the students and even administrate the whole process. Therefore, every LMS contains a Content Management System, CMS that helps to organize courses by sorting and making resources readily available to the students. The Teacher is able to place these in sequential order to reveal

them only when it is necessary for the students to know. Courses can be structured to suit any formats ranging from simple course activities to weekly time schedules.

The teacher is also able to assess and score the students through this same LMS. Massive Open Online Courses (MOOC) using LMS even make this process a lot simpler by introducing the peer-to-peer review. Several students can be made to exchange their works and review each other's work based on the recommendations by the instructor. By this way, a Massive Open Online Course can cater for over thousands of a course's subscribers.

LMS provide another way of advancing courses in the sense that students can be made to answer questions after every session. They must answer correctly before the software allows them to advance the topics. [8] [9.]

2.1.3 Examples of LMSs

LMSs comes in two categories; open-source or private. Some private LMSs build on open-source LMSs. Popular open sources are listed below:

Moodle by Moodle Pty Ltd. Open Source LMS with tons of features.

Sakai by The Sakai Foundation. Fully featured Open Source LMS for learning.

BusinessLMS by LMS Global. Open Source LMS for businesses.

ATutor LMS by ATutor. Open Source LMS implementing a social network, ATutor Social
A more comprehensive list is provided in Appendix A.

2.2 Massive Open Online Courses (MOOC)

2.2.1 Massive Open Online Courses Explained

MOOC stands for Massive Open Online Courses. MOOC makes it possible for several students all over the world to study online through a portal moderated by one or more teachers who can be based anywhere in the world without the need for a physical presence or a classroom.

MOOC courses are free and can be taken and completed online entirely usually using an LMS such as Moodle. Currently, there are close to six hundred (600) corporate learning management systems as far back as 2014, some are based on open source LMS projects such as Moodle and others purely built in-house. [7.]

Most of the time these portals are resourced with static or interactive lecture notes, videos, and podcasts or audio files. Some institutions also use these LMSs to augment teaching which is referred to as 'blended teaching' [10]. These resources such as videos are uploaded onto a server to serve as a reference for students to always fall back on during a lecture. The video can be paused and re-watched several times until the student feels he/she understands the concept being taught. This is what is termed 'self-paced learning' [10].

Self-paced learning is enhanced in the sense the resources in the form of the audios and videos can be saved to watch at any free time of the students as well.

2.2.2 Examples of MOOCs

MOOC courses are usually associated with elite institutes who make some of their lessons available to the public for free. Some examples include:

- Open Yale: Free online courses by Yale University. Usually, introductory courses are offered here free of charge.
- Open University of Finland. Free online courses organized by selected Finnish institutions.
- MIT Free Courses: Early adopter institution of open online education.
- Udemy: A site that allows anyone to build and online course.
- iVersity.Org: Offered mainly by lecturers from selected German institutes.
- Stanford Free Course: A pioneer in the offering free online education. [7.]

These are just a few of the most popular in the market now. It is normal to see about a thousand (1000) to two thousand (2000) enrolments per course on these platforms and only one or two lecturers are assigned to these courses. However, do not panic because the scoring techniques or methods to advance these courses have been explained in details in Chapter 3 below:

3 LMS Installation

3.1 Theory: Moodle Explained

Moodle is one example of the many Learning Management Systems currently on the market that offers a creative experience for effective online teaching and learning in a social, collaborative setting anytime and at anywhere.

Moodle is open-source and so that means it is free to use or its source code tweaked anyhow to adopt as one's private project. It is offered under the Free Creative Commons License.

3.2 Features of Moodle

Moodle is a resource packed LMS. The features can be categorized under three (3) groups, namely:

3.2.1 General Features

Some general features aside from the fact that the latest Moodle platform is modern and comes with an easy to use interface also provides a personalized dashboard for organizing and showing lessons. It has collaborative tools known as activities which include forums, wikis, glossaries, database activities, and chats amongst others.

The calendar helps to track course progress, deadlines, and any other personal events. A lecturer can schedule tasks for the students using the calendar plugin. Students, in turn, can monitor their general activities on the entire site through the calendar.

The progress of learning can be tracked easily topic by topic or traced by assignments completed. There is a plugin for notifications which when enabled will alert students about course creations, deadlines, forum contributions or even SMS alerts.

3.2.2 Administrative Features

From the administrative perspective, Moodle offers a very customizable site design and layout using one's own logos or theme. In this project, theme design is outside the scope and so I used an existing theme I had customized to implement the website for www.evarsity.net. Moodle provides a simple plugin management tool that makes the installation process less cumbersome. It also makes it possible for one to design and implement their own plugins to work with Moodle. [10.]

As an admin, one can as well enroll students in bulk or provide a secure authentication process where users can create their own user accounts and enroll in courses that allow them to. Enrolment times can be a continuous time process or limited to a specific period of time. Administrators can address site security issues by assigning and defining specific user roles and permissions.

Moodle supports multiple languages through the language plugin and so it can be installed in any spoken or written language as a matter of choice. That is how MOOC achieve its purpose of reaching out to multiple countries all around the world.

Courses can as well be created in bulk, archived or backed up for future dependencies. Finally, as a Moodle administrator, one has at his disposal a more detailed reporting and logging system. There is the opportunity to generate reports on the various activities and user participations or interactions with the site. [10.]

4.2.3. Course Development and Management Features

In this section, the pedagogy of the learning process can be designed to suit any style for any particular course. Courses can be instructor-led, allowed to be self-paced, blended with a physical lecture or designed to be entirely online. In this project, my goal is to make the learning process entirely online for courses which allow it by moving the live lecture online as well.

These features are designed to encourage collaboration amongst students and foster positive interaction with external resources. There is built-in media support for video and audio inserts as well.

Moodle offers peer and self-assessment activities that encourage students to review themselves, mark and assess their own or other course's participant's assignments. This hitherto was the sole responsibility of a teacher but now he/she is greatly relieved of it. In some cases, questions can be set in between lecture notes or videos and a student is required to answer correctly before the system allows him/her to advance the topic. By so doing the teacher can be sure that all the students who advance the topics to a certain point have understood the key points he intended to teach the students.

A good aspect of this feature is that the teacher is able to collate the number of students who failed a particular question and their wrong answers they provided. This way the teacher can ascertain the cause for the misunderstanding, review his/her teaching method immediately or seek to correct the anomaly as soon as possible. The self-assessment marking scheme can be plotted on a graph to show the correlation between the right or wrong answers given relative to the student proportion.

Moodle integrates badges as a reward mechanism to motivate students and reward them for their participation or achievements. Several MOOC sites give certificates after completing a course or project. These certificates are verifiable and can aid learners in their quest for job employment. [10.]

3.3 Technical Approach: Step-by-Step Guide

3.3.1 Moodle Installation

Despite all the features enumerated above, Moodle was particularly chosen as my LMS because it is by far the most used and advanced LMS in the market. Moodle 3.0.3 was installed on a clean Ubuntu server version 1404 server. The server installation process is not included in this project since it is out of scope. Note that the server needs to have access to the internet for easy downloads and installations. A virtual dedicated cloud-based server was used for this project.

Step 1: Preparing the server for Moodle Installation

In the following process, assuming the Ubuntu 1404 server is installed with *SSH* access. Installations was done mainly through the command line.

For Moodle to work, make sure a web server, a database, and PHP are installed. Install Apache, MySQL database, and PHP if not available already. However, begin by updating the server.

```
sudo apt-get update
```

Listing 1. Code to update Ubuntu packages. [1] [13]

The *apt-get* command in Listing 1 above is used as a very handy command-line tool which stands for Ubuntu's Advanced Packaging Tool (APT). It performs functions such as the installations, upgrades, and updates of new and existing software packages and even upgrades the entire Ubuntu system. In this case, it updates the existing software.

Next is to install the Apache, MySQL database and PHP using the single line of code below:

```
sudo apt-get install apache2 mysql-client mysql-server  
php5
```

Listing 2. Code to Apache server, MySQL, and PHP5

Listing 2 above uses the same *apt-get* tool to install Apache2 web server, MySQL database, and PHP. A prompt to enter a root password for the MySQL database shall pop up. Enter the root password to proceed. Remember to write it down for future reference. Use the right and left arrow keys on the keyboard to advance and press the Enter key to accept any license agreements. Next, install additional software modules and restart the Apache2 web server in order for the modules to load correctly.

```
sudo apt-get install graphviz aspell php5-pspell php5-  
curl php5-gd php5-intl php5-mysql php5-xmlrpc php5-ldap  
clamav
```

Listing 3. Install Ubuntu server dependencies [1]

```
sudo service apache2 restart
```

Listing 4. Restart the Apache web server [1] [13] [15]

Listing 3 installs the needed software and listing 4 restart the Apache web server to reload the installed modules.

Webserver installation is done and the server is ready to host any websites.

Step 2: Install Moodle

Next, install Moodle LMS. Moodle can be installed through Git. Moodle developers use the Git platform for revision and development. Repository of Moodle can be found on GitHub.

Git is a widely used source code management software by software developers for software development and revision for data integrity. Note that this is different from GitHub, which is usually used as the storage for repositories of software developed using Git as a revision control system. GitHub shall be explained further down this project. At this moment, install the git-core application if it's not already available.

```
sudo apt-get install git-core
```

Listing 5. Install git tools [1] [16]

Listing 5 code downloads and install the necessary git-core applications needed to download the software repository for Moodle. Moodle LMS can now be downloaded. Use the latest version, currently at 3.0.3.

```
cd /opt
```

Listing 6. Change directory

```
sudo git clone git://git.moodle.org/moodle.git
```

Listing 7. Download Moodle from git repository

```
cd moodle
sudo git branch -a
sudo git branch --track MOODLE_30_STABLE origin/MOODLE_30_STABLE
sudo git checkout MOODLE_30_STABLE
```

Listing 8. Code to select Moodle version to work with [1] [16]

Listing 6 changes directory to `/opt` and Listing 7 downloads Moodle and stores it in a folder named `moodle`. Git which branch (version) of the Moodle master to track and `checkout`. Listing 8 checks out the latest version of Moodle LMS version 3.

However, having installed Apache2 as the web server it is important to note that websites are served from the `/var/www/html/` directory. Moodle was intentionally downloaded into the `/opt` directory to be copied over to the `/var/www/html/` directory later. This avoids any surprises of unwanted updates should the need to upgrade Moodle version in the future using `git pull` arises.

```
sudo cp -R /opt/moodle /var/www/html/
```

Listing 9. Copy Moodle to web root [1]

```
sudo mkdir /var/www/html/data
```

Listing 10. Create a new directory to cache files

```
sudo chown -R evarsity /var/www/html/data
sudo chmod -R 777 /var/www/html/data
```

Listing 11a. Change permissions to directory to make it accessible during installation process.

```
sudo chmod -R 0755 /var/www/html/data
```

Listing 11b. Required directory permission for production

Listing 9 copies the entire downloaded `moodle` directory over to the public directory. Listing 10 creates a new directory called `data` in the name public directory. This directory is used to store cached data files which shall be explained further in this project. Listing 11 grants directory ownership and permissions to the `data` directory. Note that after the installation process the permissions on the `data` file needs to be changed to `755`. `755` gives read, write and execute rights to the owner, read and execute rights to assigned group and others. This is the required settings for the production site.

Step 3: Setup MySQL database

The Moodle site require the MySQL database to store files. Therefore, it needs to be informed of how to communicate with the MySQL server. Start the MySQL server.


```
sudo service mysql start
```

Listing 12. Code to start MySQL server [1] [17]

```
sudo service mysql restart
```

Listing 13. Code to restart MySQL server [17]

```
mysql -u root -p
```

Listing 14. Prepare MySQL server to work on [1][13][17]

```
CREATE DATABASE evarsityDB DEFAULT CHARACTER SET utf8
COLLATE utf8_unicode_ci;
```

Listing 15. Create a database for Moodle

Listing 12 starts the installed MySQL server. It is usually up and running after the MySQL installation process evoked as far back in Listing 2 and so a restart is all that is needed to confirm that it is working. Listing 13 restarts the MySQL server.

Next, a database was created for the Moodle website. Listing 14 was run to gain root access to the MySQL server. A prompt to enter the password created during the MySQL server installation process popped up again. The password was entered to advance the process. The command line changed to `mysql>`.

A database called *evarsityDB* was created using Listing 15. Next, a user was created to access the *evarsityDB* database and granted permissions to perform database queries.

```
CREATE user 'evarsityUser'@'localhost' IDENTIFIED BY
'evarsityDBUserpass';
```

Listing 16. Creates a user *evarsityUser* to access the database.

```
GRANT SELECT, INSERT, UPDATE, DELETE, CREATE, CREATE
TEMPORARY TABLES, DROP, INDEX, ALTER ON evarsityDB.* TO
evarsityUser@localhost IDENTIFIED BY
'evarsityDBUserpass';
```

Listing 17. Grants some functionality permissions to user on database

```
quit;
```

Listing 18. Quit the MySQL command mode [1] [13] [17]

Listing 16 creates the user `evarcityUser` with password `evarcityDBUserpass`. Listing 17 grants some select database functions permissions to `evarcityUser` on the `evarcityDB` database. Listing 18 exits MySQL root access mode. The command line shell returns to `$` or `#` depending on which level of access. The dollar sign (`$`) signifies a user level and the hash (`#`) sign signifies a root user level. Any user can execute root commands by simply preceding the codes where necessary with `sudo`. [1] [13]

Step 4: Finish Setup

All was set now for the final Moodle LMS installation. The rest was done on a web browser through a URL, `http://evarcity.net/moodle`. During the running of the installer process, a file `config.php` was created and so the `moodle` directory needed to be readable, writable and executable temporarily. Therefore, the code shown in Listing 19 below was executed:

```
sudo chmod -R 777 /var/www/html/moodle
```

Listing 19. Changes permissions to allow read, write and execute access to Moodle folder temporarily.

```
sudo chmod -R 0755 /var/www/html/moodle
```

Listing 20. Moodle directory's required permissions

Listing 19 changes the permissions on the `moodle` directory and its contents to allow for the creation of the `config.php` file. After the installation process remember to change the permissions using Listing 20. Listing 20 gives full access to the directory owner but non-writable to any group or others.

A browser with internet access was used to navigate to `http://evarcity.net/moodle` in order to complete the rest of the installation process.

Listed below are a few links and information noted in order to advance peacefully the installation process: Note the path for data: `/var/www/html/data`

This directory is very important to the installation process because this is where all data concerning the Moodle site is cached. Keep a memory of it handy because it might become handy to move the Moodle installation to another server in the future. In this project, Moodle had been installed on a managed shared hosting account. Several managed shared hosting providers such as GoDaddy.com in the USA or NettiHotelli.fi in Finland have different server configurations to store this *data* file. Watch the permissions carefully and adjust them to suit the new installation else some images may not load correctly or there may appear to be a broken link to these files. [2]

Table 1. Database Settings

Prompts	Answers
Database Type	mysqli
Host server	localhost
Database	evarcityDB
User	evarcityUser
Password	evarcityDBUserpassword
Tables Prefix	mdl_

A couple of environmental checks may be required but everything was at this moment.

3.3.2 Test Installation of Moodle

The final step in this installation process was to create a Moodle site administrator account. This provides the administrator permissions to access the Administrative features talked about earlier. The password may have to satisfy certain rules. Installation of Moodle LMS was now complete. The web page is the default theme. This can be changed for other free themes.

A check at the URL of the server where Moodle was installed, *www.evarcity.net* proved that Moodle was installed correctly. The current theme which is being used for the eVarcity website was installed. A screen shot of the website can be seen at Appendix D.

Moodle comes pre-installed with some themes. These themes can be selected for various devices or even for specific course pages. For instance, a particular theme can be selected to appear on mobile phones only or a group of students accessing a particular course page. To install a new theme, one needs administrative rights to navigate to the *site administration* link which can be found at the admin user's *dashboard*. Choose *Plugins* and *Install plugins* as shown in Figure 6 below. Plugin installation shall be explained further in the project in Chapter 6 below.

4 Web Conferencing System: Theory

4.1 Theory: Web Conferencing System Explained

A web conferencing system is basically software that enables real-time online collaboration or communication (RTC) between two or more parties who can see the same screen at all times using web browsers on their internet connected devices.

Some common web conferencing features includes messaging, Voice over IP (VoIP), screen sharing or presentation and in many cases abilities to host multiple live video streaming sessions.

Until recently web conferencing has mainly been used for corporate online meetings, webinars where a single user delivers a presentation to a group of people or even in one-on-one online meeting sessions. Web conferencing can be categorized into two groups as well, free open source or private proprietary software. Corporate bodies have largely been possession of these powerful features for a long time but a new wave of very new open source web conferencing software are springing up in recent years. Some popular latest free Open Source web conferencing software include:

- Openmeetings by Apache Foundation.
- BigBlueButton by BigBlueButton Inc.
- Adobe ConnectNow by Adobe
- Dimdim etc.

A comprehensive list of both commercial and Open Source web conferencing software can be found in Appendix B.

In this project, BigBlueButton web conferencing software was installed on a separate Ubuntu server. In this case the software is resource intensive and so install no other programs that may hamper the smooth running of the software. But first some little theory on what BigBlueButton has to Offer.

4.2 BigBlueButton Open Source

4.2.1 BigBlueButton Explained

BigBlueButton is a free web conferencing system built on several open source components. It was specifically built with the goal of facilitating on-line learning. BigBlueButton development started in 2007 at Carleton University, Ottawa Canada when Dr. Tony Bailetti then director of Technology and Innovation management (TIM) program felt he needed to reach his global students. However, the commercial web conferencing systems used by the school was too expensive. Commercial web conferencing systems are usually priced according to the number of concurrent users allowable and users are likely to be limited to the number of sessions per time frame. An early version of BigBlueButton was built around red5 to replace the commercial solution to enable the instructors to reach their global audience. Red5 is also an open source media server for live streaming. [18.]

4.2.2 Features of BigBlueButton

BigBlueButton provides functions to record and playback live lectures. Students can access these video files anytime. This is really helpful if a student misses a lecture or does not remember how a lecturer went about a particular topic he/she can also playback the complete lecture for revision.

BigBlueButton also provides us with a whiteboard where the lecturer can write on as he/she speaks. It also acts as a pad for presentations using pdf or PowerPoint slides. Basically, any blank pdf page acts as a whiteboard similar to what is installed in conventional classrooms for writing.

The lecturer can as well share his/her desktop to demonstrate the use of any software or provide any walkthrough demonstrations. All this happens in the cloud and there is nothing to download or install on the client PC.

Finally, a lecturer or class moderator can grant access to participating students to take over presentation roles. What this means is that students can as well do presentations in a virtual classroom just as it is done on any conventional classrooms.

All that a user may need to access the installed software is a PC or any other mobile device with internet access. [19.]

5 Installing BigBlueButton

5.1 Technical approach: Preparing Server for Installation

BigBlueButton is server resource intensive, therefore, it is recommended that no other application runs alongside. The procedure to install the server cannot be skipped at any moment because every step depends on the success of the previous steps. If an installation step fails it is advisable to resolve it before continuing with the installation process.

BigBlueButton strictly insist that minimum requirements are met for the BigBlueButton server to function as expected. The minimum requirements are:

- Ubuntu version 14.04, 64-bit server.
- 4 GB of memory (8GB is better)
- Quad-core 2.6 GHZ CPU (minimum)
- 500G of free hard disk space for recordings.
- 100 Mbits/sec bandwidth (symmetrical)
- Dedicated hardware [4]

A virtual server with 8GB of RAM memory and 80 GB of hard disk space was used in this project.

Step A: Prepare the server

Firstly, check the file `/etc/apt/sources.list` and uncomment the lines that contain *trusty multiverse*. These are URLs from which shall be downloaded packages to install. It can

easily be achieved by issuing `sudo pico` command or by running the code below as in Listing 21.

```
grep "multiverse" /etc/apt/sources.list
```

Listing 21. Code to uncomment lines containing “multiverse” [4] [13]

The file output on the screen should look something similar to what shown in Figure 1 below:



```
GNU nano 2.2.6 File: /etc/apt/sources.list

## team. Also, please note that software in universe WILL NOT receive any
## review or updates from the Ubuntu security team.
deb http://iad-public-cmh-zone-1.clouds.archive.ubuntu.com/ubuntu/ trusty universe
deb-src http://iad-public-cmh-zone-1.clouds.archive.ubuntu.com/ubuntu/ trusty universe
deb http://iad-public-cmh-zone-1.clouds.archive.ubuntu.com/ubuntu/ trusty-updates universe
deb-src http://iad-public-cmh-zone-1.clouds.archive.ubuntu.com/ubuntu/ trusty-updates universe

## N.B. software from this repository is ENTIRELY UNSUPPORTED by the Ubuntu
## team, and may not be under a free licence. Please satisfy yourself as to
## your rights to use the software. Also, please note that software in
## multiverse WILL NOT receive any review or updates from the Ubuntu
## security team.
deb http://iad-public-cmh-zone-1.clouds.archive.ubuntu.com/ubuntu/ trusty multiverse
deb-src http://iad-public-cmh-zone-1.clouds.archive.ubuntu.com/ubuntu/ trusty multiverse
deb http://iad-public-cmh-zone-1.clouds.archive.ubuntu.com/ubuntu/ trusty-updates multiverse
deb-src http://iad-public-cmh-zone-1.clouds.archive.ubuntu.com/ubuntu/ trusty-updates multiverse

## Uncomment the following two lines to add software from the 'backports'
```

Figure 1. /etc/apt/sources.list file output

As shown in Figure 1 above the URLs related to the multiverse packages are uncommented. It does not matter how the URLs look here since there are tons of mirror sites for downloading package files.

Next, run a series of updates and distribution upgrades. Just as it was done earlier, use the apt-get package installer updater shown in Listing 22.

```
sudo apt-get update
sudo apt-get dist-upgrade
```

Listing 22. Codes to update Ubuntu packages [13]

All that is needed to prepare the server for further installation is ready now after listing 22. The subsequent steps install the necessary tools for the proper functioning of BigBlueButton.

Step B: Install LibreOffice

LibreOffice handles all the office related documents to be used in BigBlueButton. It converts all MS Office documents to PDF files. Ubuntu1404 comes preinstalled with an earlier version of LibreOffice 4.2. Upgrade to LibreOffice 4.4 version by simply running the codes shown in Listing 23.

```
sudo apt-get install software-properties-common
sudo add-apt-repository ppa:libreoffice/libreoffice-4-4
```

Listing 23. Code to install ppa for LibreOffice 4.4 [4] [12]

Step C: Install BigBlueButton Key

The server needs access to the BigBlueButton package repository by way of downloading a key using the code in Listing 24. Listing 25 appends the URL to download the BigBlueButton server to the sources file list.

```
wget http://ubuntu.bigbluebutton.org/bigbluebutton.asc
-O- | sudo apt-key add -
```

Listing 24. Code to download and add BigBlueButton Key [4]

```
echo "deb http://ubuntu.bigbluebutton.org/trusty-1-0/
bigbluebutton-trusty main" | sudo tee
/etc/apt/sources.list.d/bigbluebutton.list
```

Listing 25. Code to add URL to download BigBlueButton server [4]

The Ubuntu packages were updated again using the package updater as in Listing 22.

Step D: FFMPEG Installation

FFmpeg server is needed for the playback functionality. FFmpeg is a cross-platform solution that handles the live or recorded audio and video for smooth streaming. It comes with a number of audio/video codec libraries. It is a community-driven project free under the Creative Commons license.

FFmpeg is used by giant companies like Facebook, Google (Chrome and YouTube) for converting uploaded videos. The FFmpeg Tools includes the following:

- FFserver: The multimedia streaming server used for the live web conferencing.
- FFmpeg: A command line tool for file conversions
- FFplay; the media player and
- FFprobe; the multimedia stream analyzer

It is currently the leading multimedia framework which handles live streaming, audio/video file encoding, decoding and transcoding. [14.]

Required version is 2.3.3 because the newer version does not support all the functions needed from FFMPEG for the BigBlueButton server to perform as expected. The installation process was very tricky.

Create a file and name it `installation-file-ffmpeg.sh` using the `sudo pico` command and place in the following script in Appendix C. Next make the `ffmpeg.sh` executable and run it using the codes in Listing 26.

```
chmod +x installation-file-ffmpeg.sh
./installation-file-ffmpeg.sh
```

Listing 26. Codes to execute and install FFmpeg file [4]

Now, verify to see if FFmpeg is installed correctly by running the code in Listing 27 below.

```
ffmpeg -version
```

Listing 26. Code to check the version of FFMPEG installed. [14]

The output should be as shown in Figure 2 below. With FFMPEG installed, proceed to install the BigBlueButton Server.

```
evarsity@BBBUbuntu1404Dev:~$ ffmpeg -version
ffmpeg version 2.3.3 Copyright (c) 2000-2014 the FFmpeg developers
built on Apr 17 2016 03:10:00 with gcc 4.8 (Ubuntu 4.8.4-2ubuntu1~14.04.1)
configuration: --enable-version3 --enable-postproc --enable-libvorbis --enable-libvpx
libavutil      52. 92.100 / 52. 92.100
libavcodec     55. 69.100 / 55. 69.100
libavformat    55. 48.100 / 55. 48.100
libavdevice    55. 13.102 / 55. 13.102
libavfilter     4. 11.100 / 4. 11.100
libswscale     2.  6.100 / 2.  6.100
libswresample  0. 19.100 / 0. 19.100
evarsity@BBBUbuntu1404Dev:~$ █
```

Figure 2. FFmpeg version output.

Figure 2 shows the desired version of FFMPEG installed and the audio/video library of codecs necessary.

Step E: BigBlueButton Installation

Finally, all was set for the installation of BigBlueButton server. All that was needed was the single line of code shown in Listing 27 below. Again, the package installer updater was used to connect to the necessary URLs from the sources list amended to download and install BigBlueButton. This process may took quite some time .

```
sudo apt-get install bigbluebutton
```

Listing 27. Code to install BigBlueButton server [4]

Listing 27 installs BigBlueButton server. Pay attention to the process. Look out for prompts to respond to in order to continue with the process as shown in Figure 3 below.

```
odbcinst1debian2 patch pkg-config poppler-data poppler-utils python-debian
python3-uno redis-server redis-tools rsync ruby ruby1.9.1 ruby1.9.1-dev sox
tomcat7 tomcat7-common tsconf ttf-mscorefonts-installer unixodbc uno-libs3
unzip update-notifier-common ure vorbis-tools xfonts-encodings xfonts-mathml
xfonts-utils zip zlib1g-dev
0 upgraded, 269 newly installed, 0 to remove and 0 not upgraded.
Need to get 437 MB/507 MB of archives.
After this operation, 1,209 MB of additional disk space will be used.
Do you want to continue? [Y/n] █
```

Figure 3. Prompt to proceed with BBB installation.

Enter 'Y' and confirm to continue the process all the way to the end as shown in Figure 3 above.

5.2 Testing BigBlueButton Installation

Now that BigBlueButton server is installed here are some few tips to note: To restart the server it is always best practice to do a clean restart using the codes in Listing 28.

```
sudo bbb-conf -clean
sudo bbb-conf --check
```

Listing 28. Codes for restarting and checking error exist on BBB server [4]

Listing 28 provides a clean restart method by shutting down all the processes and clearing all logs as it tries to restart. If there are any errors with the server configurations the results shall be printed onto the screen. The final output is as shown in Listing 29 below:

```
** Potential problems described below **
# IP does not match:
#
#           IP from ifconfig: 10.195.38.12
#   /etc/nginx/sites-available/bigbluebutton: slate.evar-
#   sity.net
# Warning: API URL IPs do not match host:
#
#           IP      from      ifconfig:
10.195.38.12
#   slate.evarsity.net
#   http://slate.evarsity.net/demo/demo1.jsp
#   sudo apt-get purge bbb-demo
#   http://slate.evarsity.net/check
```

Listing 29. Final Output after a successful BigBlueButton clean restart

BigBlueButton Installation was complete now. Initially, I run into a few issues when I ignored the version of FFmpeg 2.3.3 required for BigBlueButton and installed the latest FFmpeg version. It was solved by removing all the unwanted server installations including unspecified versions. This time on a more powerful and clean server was used.

Next, was to access the server to check if everything worked as expected by using any web browser to navigate to the BigBlueButton server's external IP address, `www.slate.evarsity.net/demo/demo1.jsp`. Prior to that, execute a final line of code to install a demo server of BigBlueButton for to play around with. It is not advisable

to keep this demo server on a production site. Since BigBlueButton was installed purposely to integrate it with Moodle, the demo server needs to be deleted after testing. Listing 30 below installs the BigBlueButton demo server.

```
sudo apt-get install bbb-demo
```

Listing 30. Installs a BigBlueButton demo server for testing purposes only. [4]

Figure 4 below shows a snapshot of the BigBlueButton interface at www.slate.evarsity.net/demo/demo1.jsp

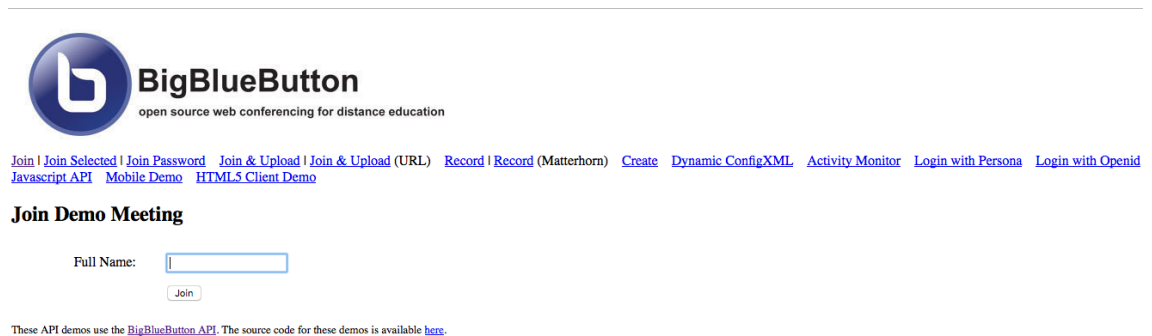


Figure 4. BigBlueButton demos page at www.slate.evarsity.net/demo/demo1.jsp

As shown in Figure 4 above the Open Source BigBlueButton server installed correctly and is now ready for web conferencing. Enter any name to join a demo conference room for testing purposes.

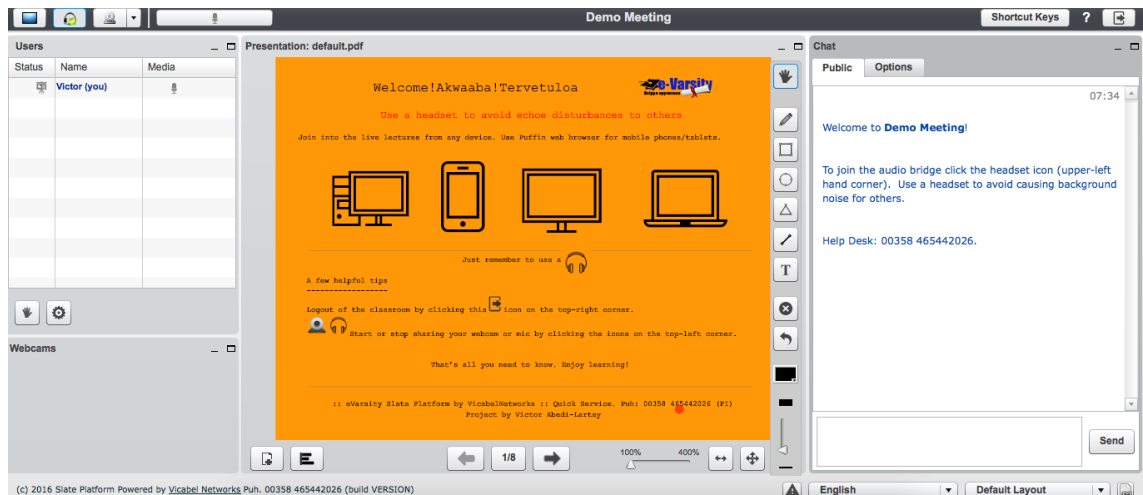


Figure 5. A demonstration of the conference room on BigBlueButton server.

As shown in Figure 5 above, the BigBlueButton just allowed a user to join a demo conference room. The Figure 5 above shows a customized outlook done purposely to suit the eVarsity theme. BigBlueButton needs to be installed in a developer mode to be able to have access the source codes.

Note that some servers come pre-installed with two IP address, one external IP, and another internal IP address. BigBlueButton usually binds with the internet server starting with dotted decimal that looks like this 10.x.x.x or 192.168.x.x. If this happens BigBlueButton can never be accessed via the public IP. Run the script to reconfigure it to resolve to the server's external IP. The script to bind the BigBlueButton to the external IP is `sudo bbb-conf --setip slate.evarsity.net (or SERVER's_IP_ADDRESS)`. [4.]

Now that the BigBlueButton server installation is complete and tested to see that everything works correctly, the next step is to link the Moodle LMS to the BigBlueButton Web conferencing server.

6 Linking Moodle LMS to BigBlueButton

Both projects are standalone installations at the moment running on two (2) different servers. link the Moodle Learning Management System to the BigBlueButton web conferencing software.

BigBlueButton offers APIs that can be referenced to create conference rooms on the server. This APIs can be initiated from the Moodle LMS through a plugin.

Moodle LMS, on the other hand, is also highly interoperable meaning third-party software can be integrated into it and tailored to perform certain functions. Therefore, with administrative privileges, install the Moodle plugin for the BigBlueButton.

Step I: Install BigBlueButton-Moodle plugin

Navigate to the *site administration* of the Moodle LMS site and click on *Install plugins*. The *site administrator* can be found from the *dashboard* on the left-hand side as shown in Figure 6 below.

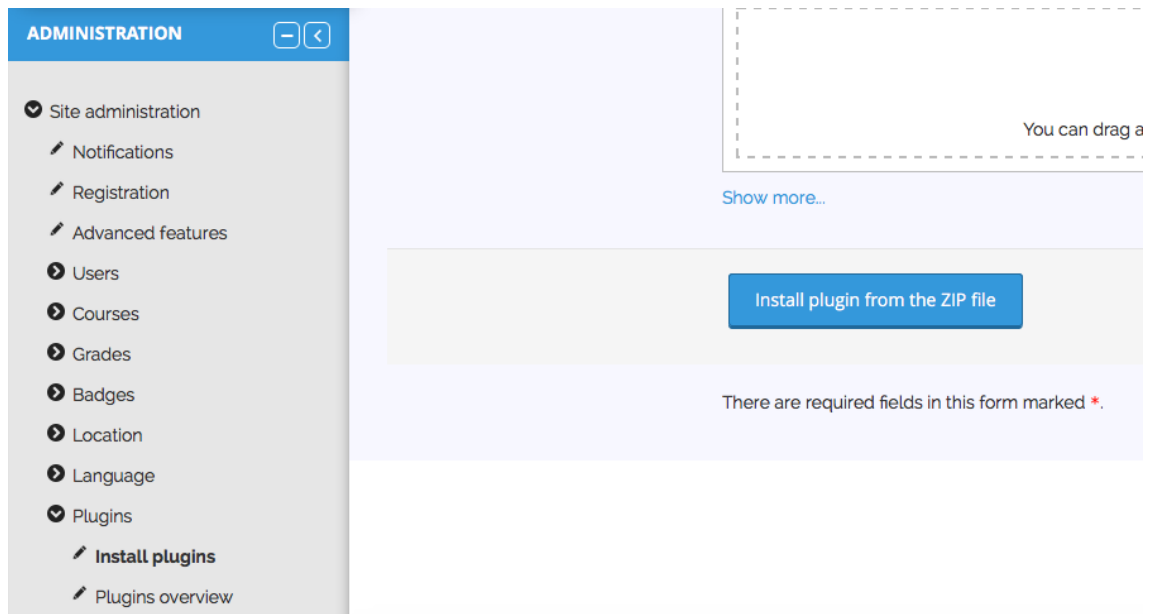


Figure 6. Link to plugin installer page from site administration

From the Plugin Installer page as shown in Figure 7 below, navigate to search for the BigBlueButton-Moodle plugin on the Moodle.Org website. A Moodle.Org account is required to do this process. Alternatively, the plugin can be download and re-uploaded to the Moodle site for installation.

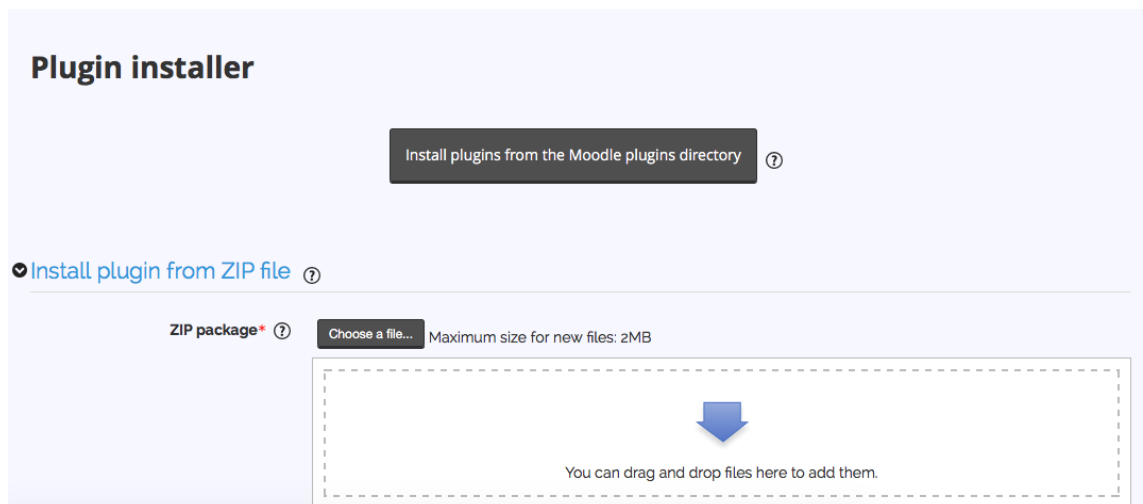


Figure 7. Plugin Installer page.

The Moodle plugin installer page should look similar to Figure 7 above. Follow all the prompts to import the BigBlueButton-Moodle plugin into the Moodle LMS. Click on update database to install the plugin.

Step II: Obtain BigBlueButton server's secret keys

Back to the BigBlueButton server installation, the necessary credentials was obtained so that the Moodle plugin can communicate with the server. Run the code in Listing 31 to obtain the secret keys.

```
sudo bbb-conf --salt
```

Listing 31. Obtaining the secret key for BigBlueButton server. [4]

Listing 31 outputs a URL and a secret key which needs to be recorded and kept safely. No other form of authentication is provided for by BigBlueButton except for this secret key. The secret key can, however, be set to a desired value.

Step III: Configure the BigBlueButton-Moodle Plugin

After the installation of the BigBlueButton-Moodle plugin imported from Moodle.Org, a setup page for the plugin is presented. If for some reason the page disappears simply navigate to the Install Plugins link on the site administration page and select Plugin overview as can be seen in Figure 6 above. A page full of a list of all the plugins installed on the Moodle LMS is presented. Search for BigBlueButton and click on the settings hyperlinked.

Finally, fill in the necessary details and save the page as shown in Figure 8 below. The server URL should always end in */bigbluebutton*.

BigBlueButtonBN

General configuration

These settings are always used

BigBlueButton Server URL Default: http://slate.evarsity.net/bigbluebutton

bigbluebuttonbn_server_url

The URL of your BigBlueButton server must end with `.php` provided by Blindsight Networks that you can use for testing.

BigBlueButton Shared Secret Default: 346fjyrykujthefsfgggfs6ac38998d9

bigbluebuttonbn_shared_secret

The security salt of your BigBlueButton server. (This can be provided by Blindsight Networks that you can use for testing.)

Figure 8. BigBlueButton-Moodle plugin settings page

Now, linking the Moodle LMS to BigBlueButton was complete. BigBlueButton is a resource-intensive server application and so it is advisable to have it on a standalone server without any application running on it.

7 Testing and Demonstration

At this stage, simply create a web conference in any course by adding the BigBlueButton as an activity which most teachers who have ever used Moodle for teaching before are familiar with.

7.1 Demonstration

A demonstration of a course with BigBlueButton added as an activity can be seen in Figure 9 below:

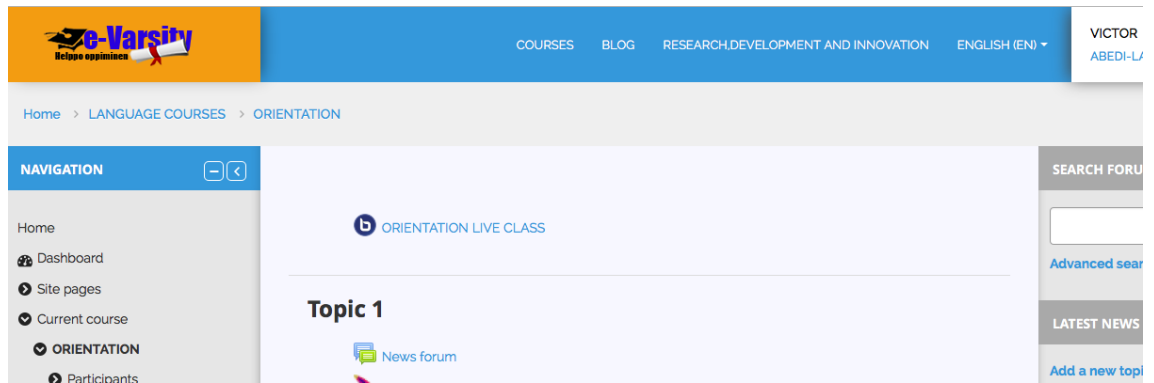


Figure 9. BigBlueButton added as an activity in a course.

As shown in Figure 9 above the link to join the live web conferencing lecture room specific to this particular course and its participants only can be seen by all students enrolled in the course named ORIENTATION. Students can click on the link (ORIENTATION LIVE CLASS) to join the lecturer in the room anytime a live lecture is scheduled for the course.

As can be seen in Figure 10, the lecturer enters the virtual classroom to allow students access. Students can as well be allowed first entrance to the class before the teacher.

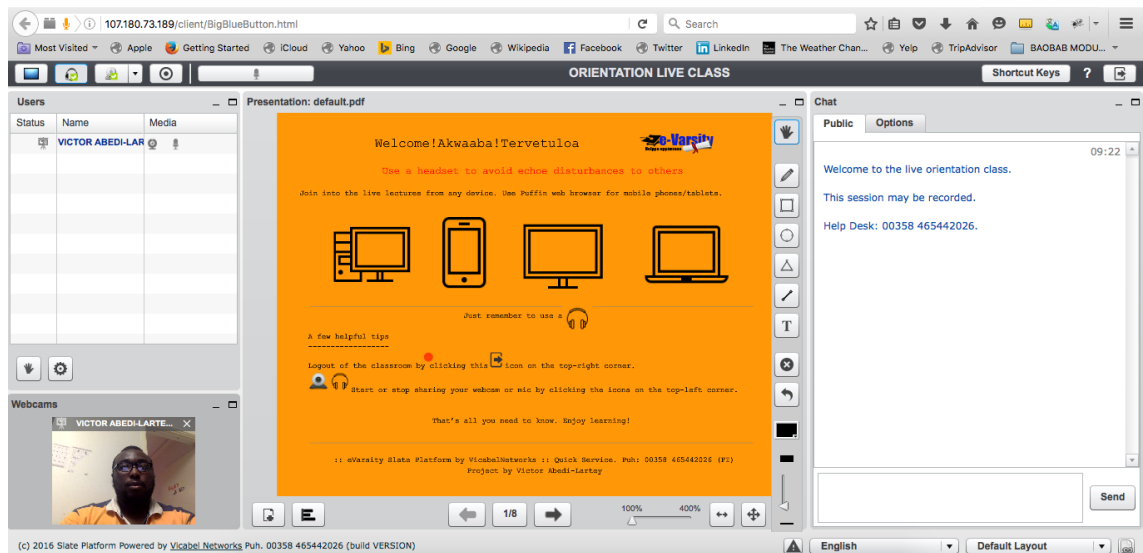


Figure 10. Lecturer enters the virtual classroom.

As shown in Figure 10 above the lecturer is allowed entrance in to the virtual classroom. Since permission is set to only allow students in after a teacher or course moderator has started the session. The virtual classroom is now open to allow students to join the ongoing live session.

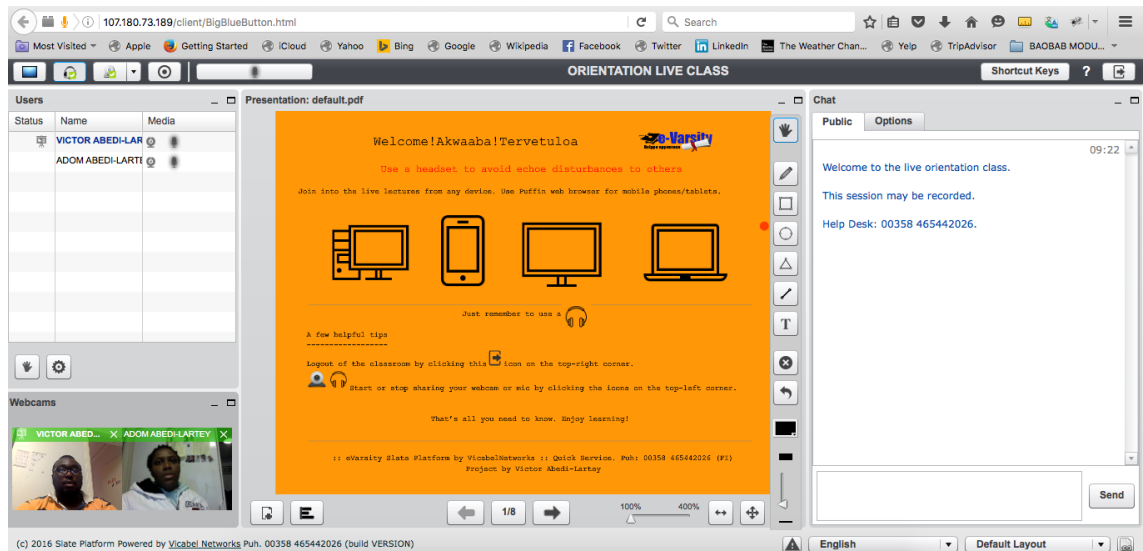


Figure 11. Demonstration of a student course participant joining into the live lecture started by lecturer

As shown in Figure 11 above, it can be seen that a student who has enrolled in the course, ORIENTATION on the Moodle LMS is able to join in to the web conferencing application. User can decide to share their webcams or join in to listen only. BigBlueButton is flash-based and so any flash-enabled browser can be used for the web conferencing. Some flash-enabled mobile browsers such as the Puffin web browser enables users to join in from their mobile phones or tablets.

7.2 User Experiences

The platform was tested with six (6) people at four (4) different locations. Three (3) of them were located in Ghana, one (1) each located in Switzerland, Finland and Sweden. It is worth noting that my test with another user in Finland at the Metropolia UAS, Leppävaara campus was one of the smoothest test. This can perhaps be attributed to the internet speed recorded on the campus using an online based tool called SPEEDTEST.NET (www.speedtest.net) by OOKLA as shown in Figure 12. 942.25 Mbps of download speed was recorded. The internet speed was not the true speed value since it was not calculated against any server closest to the BigBlueButton installation server (cloud server was located in Phoenix, USA) but it gives a general picture of the kind of speed. The audio and video were very clear. The highest quality of the video format was tested and it still turned out great. Writing on the whiteboard was easy. Students on the other hand were able to follow almost instantaneously from other location on campus.

The user experience was as expected. BigBlueButton suggest an average download speed of 1 Mbps [4].



Figure 12. Speed test on Metropolia Campus Library, Leppävaara (Espoo) April 2016.

However, that much speed was not necessary to run a successful test. A similar experience was recorded with users located in Switzerland, Ghana, and Karlstad, Sweden who recorded about 10Mbps download.

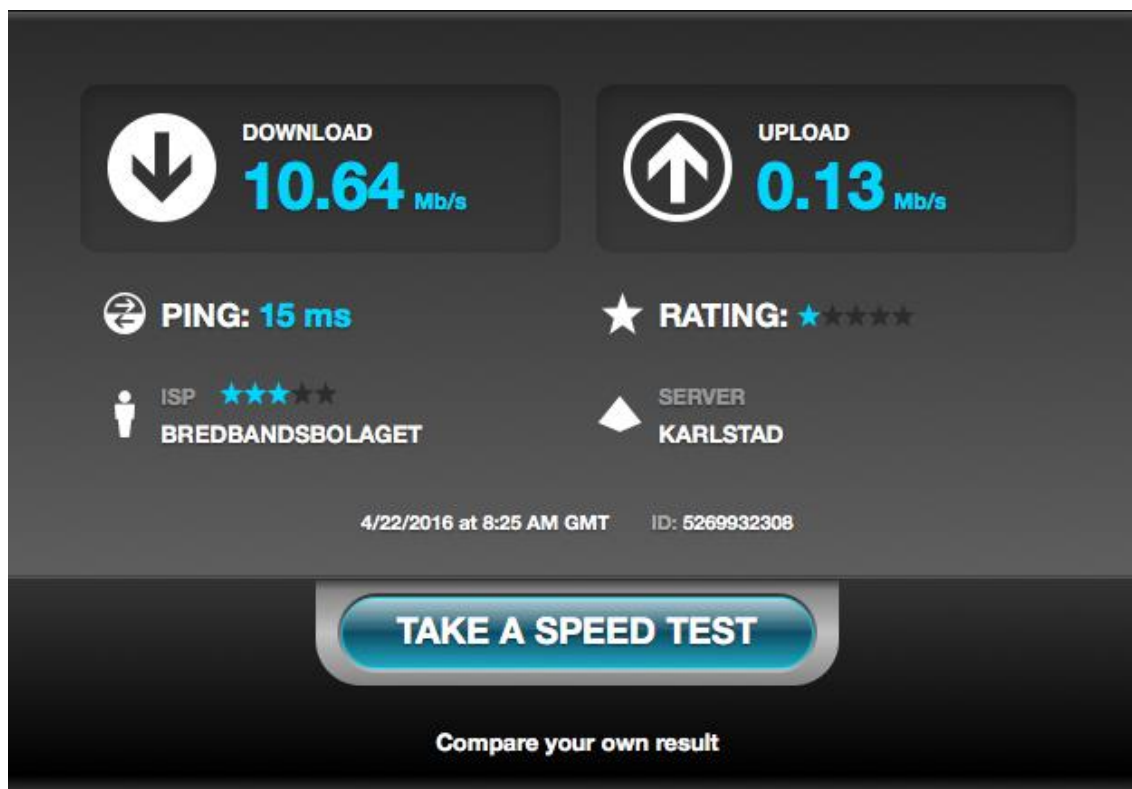


Figure 13. Speed test result recorded from Karlstad, Sweden (<http://www.speedtest.net/my-result/5269932308>). April 2016

As shown in Figure 13 above the recorded internet speed was 10.64 Mbps. The audio and video quality were still great. The users were able to follow the demonstrations on the whiteboard with no delays.

The experience with a user located in Ghana who recorded 0.33 Mbps download speed as shown in figure 14 below on the University of Ghana, Legon campus was bad. However, turning off his audio and video he was able to follow the demonstrations without any problems.

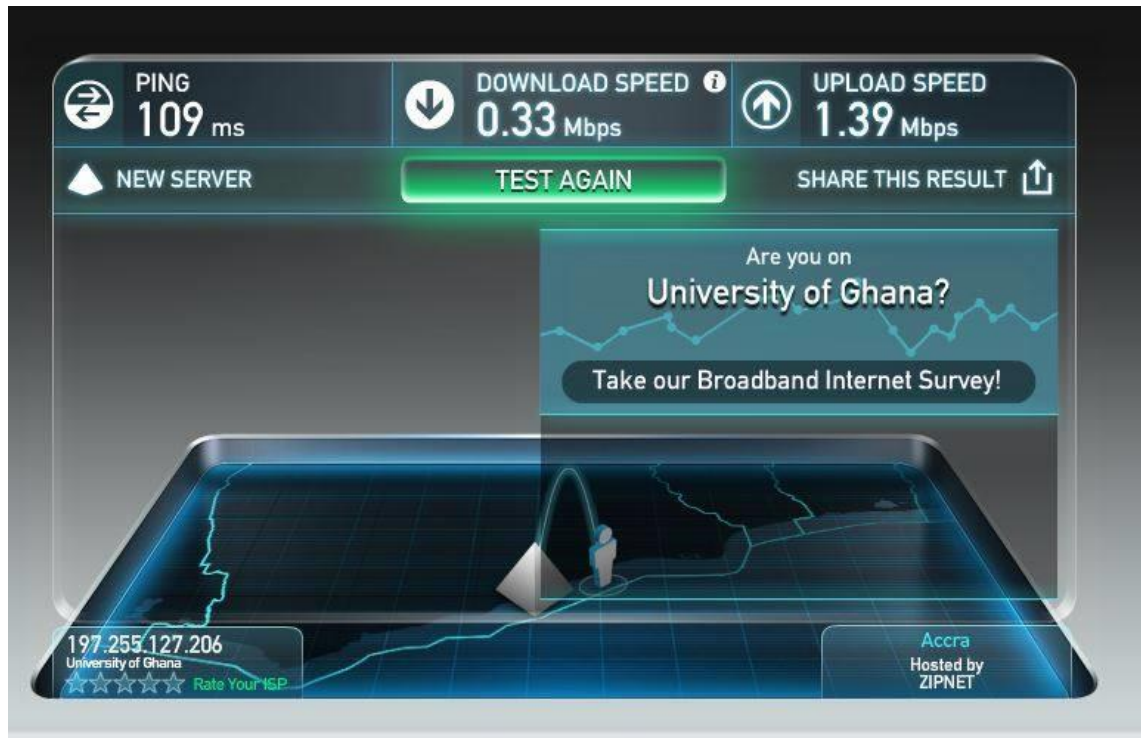


Figure 14 internet speed test recorded on University of Ghana, Legon campus. April 2016

The minimum internet speed tested so far to work with all features turned on was about 1.51 Mbps speed recorded on the same University of Ghana, Legon campus. The user was able to log in as a lecturer from the University of Ghana with the full presentation rights. He succeeded in uploading lecture notes of about 77 pages in PDF format into the virtual classroom. The user's audio and video lagged a bit for short intervals at my end.

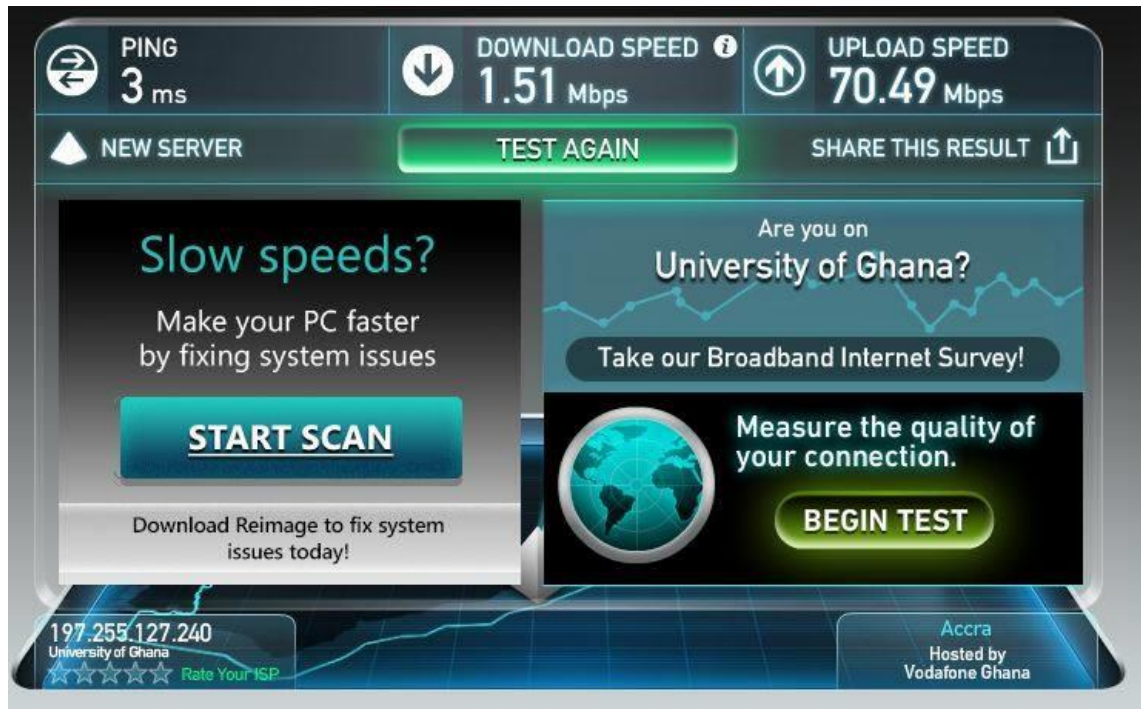


Figure 15. Internet speed test recorded on University of Ghana, Legon campus. April 2016.

As shown in figure 15 above, the internet speed improved significantly makes it possible for the user to upload files into the classroom.

8 Conclusion

The project was done by first mapping out the various LMSs and web conferencing systems currently available in the market taking a specific look at their features, stability, server requirements. After an initial background research, the project was planned. The necessary tools to execute the project was assessed. An approach was drafted. I used two (2) clean virtual machines. No software was purchased since both software codes are free to tweak. Resources for this project at the time of writing was limited to online references since it is a fairly new field.

Moodle was selected as LMS of choice due to its popularity, rapid progress of development phases and vast features it possesses. Moodle was installed on one of the virtual machines. Moodle did not require a dedicated virtual server. Any shared web space is OK.

However, my initial choice for the free web conferencing system was Openmeetings. I installed Openmeetings on one of the servers after several unsuccessful tries but integrating it with Moodle was a bit challenging. Openmeetings has so many similarities with BigBlueButton. BigBlueButton is well-resourced and documentation on the project is very extensive. The challenges faced shaped my confidence to move to test the BigBlueButton server which had very limited installation guide. BigBlueButton server installation is somehow strict, procedures cannot be skipped and permissions on the file directory system play a very critical role else there is bound to be dependency issues. I setup the BigBlueButton in a developer mode in order to be able to have access to the codes to tweak to suit this project.

In concluding, the goal of the project has largely been met. The platform provides participants of the Open University or distance learning the opportunity to live learning.

9 References

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Appendix A

1 (4)

A list of free Open Source and proprietary Learning Management Systems

Blackboard Learning System

Desire2Lear

eCollege

JoomlaLMS

SAP

HotChalkSkillsoft

Schoology

Google Classroom

Latitue Learning

Quiz

Kannu

Intuo

WeBQork

OpenOLATCanvas

eFront

Chamilo

Sakai

SWAD

Totara LMS

OLAT

LAMS

ILIAS

Claroline

EduWave

Halogen Software

Informetica

Litmos

TalentLMS

ParadisoLMS

Expertus

CERTPOINT Systems Inc.

Edmodo

Digication

Appendix B

2 (4)

A list of free Open Source and commercial Web Conferencing Software

Fuze

OpenMeetings

BigBlueButton

Adobe Connect

Onstream Media

InterCall Unified Meeting

GlobalMeet

Ready Talk

iMeet

WebEx Meetings by Cisco

GoToMeeting

MeetingBurner

iLinc

Join.me

eVoice

Microsoft Skype for Business

StartMeeting

Google Hangout

Mikogo

Web Huddle

Zoho Meeting

Zoom

Appendix C

3 (4)

Content of installation-file-ffmpeg file

```
"sudo apt-get install build-essential git-core checkinstall yasm  
texi2html libvorbis-dev libx11-dev libvpx-dev libxfixes-dev  
zlib1g-dev pkg-config netcat libncurses5-dev
```

```
FFMPEG_VERSION=2.3.3
```

```
cd /usr/local/src
```

```
if [ ! -d "/usr/local/src/ffmpeg-${FFMPEG_VERSION}" ]; then  
    sudo wget "http://ffmpeg.org/releases/ffmpeg-${FFMPEG_VER-  
SION}.tar.bz2"
```

```
    sudo tar -xjf "ffmpeg-${FFMPEG_VERSION}.tar.bz2"
```

```
fi
```

```
cd "ffmpeg-${FFMPEG_VERSION}"
```

```
sudo ./configure --enable-version3 --enable-postproc --enable-  
libvorbis --enable-libvpx
```

```
sudo make
```

```
sudo checkinstall --pkgname=ffmpeg --pkgversion="5:${FFMPEG_VER-  
SION}" --backup=no --deldoc=yes -default" [4]
```

EVarsity.Net Website

The screenshot displays the EVarsity.Net website with the following sections:

- Hero Banner:** "Enough! Start learning now ENROLL HERE" with a graduation cap icon and a call to action "ENROLL HERE".
- News & Updates:** A section with three news items: "Learning Finnish language made easy", "A graduation certificate first time the online courses that could lead to a diploma", and "Why Study Via Online Courses at EVarsity?".
- Online Education for Everyone:** A section titled "Quality Finnish-standard education now available online for everyone anywhere in the world" with four icons: "LIVE LECTURES", "INTERACTIVE", "ALWAYS THERE", and "CERTIFIED COURSES".
- Courses & Academics:** A section titled "What we offer to our students" with four course cards: "BASICS OF COMPUTER HARDWARE", "FINNISH 3A/SUOMI 3A", "ACUTE NURSING", and "ORIENTATION".
- Infographic:** A section titled "INSIDE STORY AND STATISTICS" with statistics: "987 New students ENROLL HERE", "10800+ STUDENT APPLICATIONS", "60+ RESEARCH TOPICS", and "1 Degree AWARDED".
- Student Feedback:** A section titled "STUDENTS AND LECTURERS FEEDBACK" with testimonials from Prof. Wanda Aho, Joseph Abed-Larley, and Prof. Ross Agelony.
- Map:** A map showing the location of EVarsity in Helsinki, Finland.
- Contact Form:** A form with fields for "Name" and "Email" and a "SEND EMAIL" button.
- Footer:** A section with "FORUM DISCUSSIONS", "DOWNLOAD RESOURCES", and "CONTACT WITH US" links.