

International Workshop on Enterprise Web Application Dependability (EWAD 2016)

Security and Reliability Requirements for a Virtual Classroom

Shafiq ur Rehman^{a,*}, Muhammad Umair Khan^b

^a*FAST National University, Islamabad, Pakistan*

^b*University of Management and Technology, Lahore, Pakistan*

Abstract

The continuous advancement in the field of high speed online services has opened the door for various social services. One such area is education. There are many underprivileged persons in the world who do not have access to quality education. Concerning this, we propose a Virtual Classroom system that provides users a real-life experience of a classroom environment without the need of physical presence of either the instructor or the student. In this paper, we discuss the architecture of such a system and the methodology used in developing such a system and later describes the results achieved through using it.

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Peer-review under responsibility of the Conference Program Chairs

Keywords: Security, Reliability, Virtual Classroom, Requirement Specifications, Design, Architecture

1. Introduction

Education is important for every human being as an individual and as a society. As our society becomes more complex and developed, education will become more important⁵. However, the unequal standard of education and the varying education systems and curricula across the world and even within one country are still a major problem that needs to be resolved. Subsequently, efforts are being made to make education universal and reachable for everybody especially the underprivileged and handicapped⁹. There are still some places in the world where education has not reached, resulting in mass illiteracy. Moreover, it is imperative that the right of every person to have equal opportunities to get education is honoured. As the development of a country completely depends on the availability of proper education, certain steps must be taken to improve it.

The continuous development in the field of internet has allowed us to reach people and disseminate information in a manner which was beyond our imagination just a few years ago. It has aided us in various fields of life⁶. The

Corresponding author. Tel.: +923202874114; fax: +9251410 3846

E-mail address: shafiq.rehman@nu.edu.pk

field of education has also greatly benefitted from it. Internet lets students increase their knowledge on their particular subject in the comfort of their homes and hometowns. Internet has emerged into one of the fastest and convenient tool that can be used to explore and grasp knowledge about the topics of one's interest¹⁰.

With these factors in mind, we propose, in this paper, a Virtual Classroom that allows users to use all features of real classrooms just by being online and connected to internet. It allows students and instructors belonging to different geographical locations to communicate with ease. Furthermore, it is capable of accommodating one-to-one and one-to-many coaching models. The Virtual Classroom application offers classrooms for different subjects. Students would enrol themselves into the course they desire by filling in the formalities online. The schedule of every class would be made available to the enrolled students. A database is maintained to manage attendance and student records. Other notable features include aspects from attending live video lectures to discussion forums regarding the course to assignments, quizzes and exams.

Lectures are delivered in form of a webinar; a white board would also be available to assist in delivering better understanding of the subject being taught. An instructor could take a pop quiz or carry out an activity to keep a check on the student's performance any time. Study materials such as video lectures, slides, assignments and solution to the assignments would be available on each particular course section. Students could attend the lecture online by logging in to their respective profiles; they could keep track of their attendance and progress in the course. If a student is having any issues and requires individual assistance, he/she can approach the respective instructors via the chat box option and obtain an answer to their query. The rest of this paper is organized as follows. Section 2 provides the literature review. Section 3 discusses the functional and non-functional requirements of a virtual clinic. Section 4 presents the design and architecture of the virtual clinic application. Section 5 presents the concluding remarks and future work.

2. Literature Review

Toles, in his paper, mentions that any individual who opts for a virtual learning environment is missing on the physical essence of a classroom which provides face to face interactions with not only the teacher but also the peers¹. Input from and interaction with peers is also a major part of learning and virtual education does not usually provide that. We, in our proposed system, have attempted to introduce the peer-to-peer education element by including the facility of group discussions among students using audio and video conferencing. Usually, this video conferencing facility is provided by third parts tools in existing systems. Another issue raised by Toles is that of trained professional teachers; instructors are usually fully adapted to traditional classroom teaching environment and may lack the expertise to deliver lectures on an online class. In this paper, we propose that the virtual environment should strive to be as close to the traditional environment as possible to reduce the environment-specific learning required and increase the comfort level of both the instructors and the students.

The virtual classroom discussed paper by Yang and Liu comprises of two parts: Instructional Communicating Environment (ICE) that contains learning materials and lecture videos and the Collaborative Learning Environment (CLE) that supports active learning by providing the environment with learning tools, learning materials and contextual discussion for learners². These learning processes were compared and it was found that CLE is more efficient than the ICE as it provided more interaction. This indicates that some interaction, even if it is via video conferencing, improves the learning experience. The authors state that learning efficiency is determined by learning methodology. Our proposed system is more similar to their Collaborative Learning Environment in that we also provide direct interaction facilities.

Subramaniam and Kandasamy conducted a research study in Open University Malaysia (OUM)³. OUM provides a virtual classroom environment which has been created on myVLE learning management system which is an asynchronous-based online learning framework. The aim of this study was to explore student's perception about virtual classroom and the factors that enhanced their learning capabilities and also how virtual classroom has contributed in their self-managed learning skills. The virtual classroom provided by OUM comprised of many learning materials and tools which collectively include iBook, iTutorial, iLecture, iForum, cForum, Smart Forum, iHelp and self-assessment activities. The primary results indicate that students give priority to real time classroom environment over virtual classroom. Students consider virtual classroom as a secondary choice and it has moderate impact on their learning skills³.

Parker and Martin conducted a research study in Southeastern University in the United States to compare student perception about completely online and blended courses. A completely online course is one where students and instructors cannot meet in-person whereas in a blended course half of the class meetings will have face to face interaction and the rest will be conducted online. The study aimed to examine student behavior towards the features and characteristics of a virtual classroom. Studies shows that there is no significant difference between online versus blended course performance. Yet there might be some differences in terms of course delivery model. The study was conducted on Horizon Wimba virtual classroom. Online course students gave highest priority to stored virtual classroom sessions while polling and hand raising feature were rated second. Students from blended courses give highest points to desktop sharing and viewing presentations features. Comparatively, students in completely online courses rated all features higher than blended course students⁴.

3. Requirements of a Virtual Classroom

A viable virtual classroom should provide its users with a real life like learning environment to achieve its objectives. Such a system should have a number of functional and non-functional requirements. The functional requirements of such a system are described in Section 3.1. Section 3.2 focuses on the non-functional specifications.

3.1 Functional Requirements

The main functional objectives of the virtual classroom are to create and offer courses, enrol students in offered courses, provide a platform to present and discuss materials related to a particular course, store course materials online such that they are easily accessible, and providing the tools necessary for student evaluation and feedback. The major functional requirements for the Virtual Classroom system are discussed in the following paragraphs.

The most basic of functionalities of a virtual classroom is to maintain an identity of a user. This involves adding a new profile and modifying it later. The profile may also be archived if the user becomes dormant however, from a security point of view, deleting a user profile should not be allowed. Creating and modifying an existing profile should be allowed by all users however, archiving it should only be allowed for the administrator. The users' profiles may be of students or instructors.

The second important functionality of a virtual classroom should be to manage courses that will be taught by the instructors. Similar to a user profile, each course will also have a profile which can be changed or archived. A course can be in open (students can register), closed (registration is closed but the course is being conducted), and archived (course is not being conducted currently). A searchable directory of all courses and their corresponding details should also be maintained. Students are allowed to add a course to their portfolio while it is still open. Once the course is closed for registration, students are only allowed to drop it before a date specified by the instructor. Each course will be linked to the students' profiles who are registered in that course. The instructor should be able to view certain parts of the students' profiles in accordance with the organizational policy. The virtual classroom should provide the users with a storage space for each course. Instructors can upload course material while the students can upload their completed assignments.

Most major virtual classroom systems do not include audio and video conferencing facilities. Most of the interactions is via text (email, notice boards, black boards, documents, *etc.*). The current extent of video or audio interaction is the student or instructor uploading a video of him/her which can be viewed offline. However, the element of back and forth natural conversation is missing. Some virtual classroom tools use third party tools to support video conferencing. We propose that every comprehensive virtual classroom should have a audio/video conferencing component. Such a component should allow the users to setup and initiate a conference. Users should be able to invite other users to join in. The user who initiated the conference, any person who has been given permission by the initiator, and the administrator, should have to authority to stop or modify the conference. Users may be allowed to join the conference as an active participant (participants are allowed to interrupt), as a passive participant (participants are not allowed to interrupt), and a hidden/silent participant (instructor only). Users should also be allowed to leave the conference whenever they desire. The conference initiator should also be able to allocate time slots to each speaker during the conference and himself act as a moderator.

Another important component of any virtual classroom environment is related to grading, examinations, and assignments. This playing a crucial role in allowing the instructor to keep track of the students' progress. He/she may

set up online or take-home examinations and assignments. The assignments and take home examinations should be uploaded to a secure folder only accessible by the instructor and the student who is the owner of the files. The student should be allowed to complete any online exam and assignment. The grading may be manual (in case of essay questions) or automatic (such as in case of multiple choice, true/false, matching, short answer questions). The system should keep track of all student activity related to exams and assignments for record purposes.

3.2 Non-Functional Requirements

Many virtual classroom systems have been developed and are available in the market such as Moodle⁵ and Desire2Learn⁶. We, however, also focus on the non-functional requirements of such a system. These requirements are important for the system to be able to provide educational services in a manner that the users are not discouraged and continue to learn in the virtual environment. As previously mentioned, the objective of a virtual learning environment is to reach individuals who do not have the capacity to attend a real life classroom. To achieve this, many non-functional requirements have to be catered for.

A non-Functional requirement is a requirement that judges the operation of a system. They are not functional requirements but together with functional requirements they become the core requirements of a system. Moreover, these non-functional requirements affect the manner how the software is designed and implemented. There can be many non-functional requirements of the Virtual Classroom. However, the main concerns are reliability and security (confidentiality, integrity, and availability) of the service provided by the system and the data stored in the system. The virtual classroom system should also be highly portable and conform to a minimum level of performance especially while uploading/downloading materials and audio/video conferencing.

Reliability is the property of a system that dictates that it should remain in operation under unfavourable situations. If the service is not available when it is needed the most, then the purpose of the service fails. A reliable system would include mechanisms (e.g., fault tolerance) to ensure continuity of service. Another important requirement for such a system will be security. A security requirement has been defined as a control, safeguard, or countermeasure to avoid or remove vulnerabilities that may be exploited to violate the confidentiality, integrity, or availability of data. These constraints have to be made part of the development during all its phases^{7, 8, 9, 10, 11}. The classroom materials should be preserved in a manner such that unauthorized people cannot make changes (integrity). Materials should also be available when it is required.

Performance is another important requirement for the virtual classroom. In the following subsection, we discuss some of the important reliability, security, and performance requirements.

3.2.1 Reliability Requirements

- If a user is disconnected during an audio/video conference (without the user explicitly logging out), then the connection will be restored as soon as possible without asking for his/her credentials. If, however, the connection cannot be re-established, then the time when the user was disconnected for future reference, the current state of the user's work will be saved, and the user will be logged off.
- If the connection between the user and the system is broken prior, the system shall enable the user to save the current state and continue from that state once the connection is restored.
- The system should backup user data at regular intervals to avoid loss.
- The system shall attempt to restore a lost session due to communication interruption to the point where it was broken.

3.2.2 Security Requirements

- All users should be authenticated before granting access to the Virtual Classroom.
- All users should have access according to their respective authorization privileges.
- Student should be enrolled in a course before accessing its materials and attempting its assignments and exams.

- The instructor is only allowed to mark those students absent/present who are absent/present in the virtual classroom. A student can be marked inactive if he/she is present but does not respond to the instructor or has not performed an action for a certain amount of time.
- Assignments should be uploaded before being graded.
- Exam should have been attempted before being graded.
- The instructor can only initiate a class that has been scheduled at least 24 hours in advance.
- All internet communications that involve any personal information should be encrypted.
- Instructors should only be able to access their records of students who are currently registered in their course. These records should be limited to the course that is being taught by the instructor.

3.2.3 Portability Requirements

- The design of the Virtual Classroom system should allow the application to run on all widely used browsers.
- The design of the Virtual Classroom system should cater for different screen sizes (desktop, laptop, tablet, and smartphones) and input mediums (touch screen vs keyboards and mice).
- The design of the Virtual Classroom system should be able to run on different operating systems.

3.2.4 Performance Requirements

- The system should be able to accommodate at least 50 users (approximate strength of a class) simultaneously in the video conferencing mode. This requirement will ensure that at least one class can proceed during any time slot. This requirement can be strengthened when more resources are added to the system.
- All Web pages generated by the system shall be fully downloadable in no more than 10 seconds over a 40 Kbps modem connection.
- While in the chat mode, the responses should not take more than 5 seconds to appear on the chat screen.

4. Conclusion

The purpose of this project is to provide a platform that is most helpful in gaining education online anytime and anywhere. Virtual Classroom is a complete gateway to education; this project offers classrooms for different subjects. Students would enrol themselves into the course they desire by filling in the formalities online. The schedule of every class would be notified to the students enrolled. A database is maintained to manage attendance and student records. This project could be used by anyone who seeks education thus it refers to a general audience. This project would not only increase the rate of literacy but would introduce an entirely new approach that would be feasible in many ways for different people.

The Virtual Classroom has been deployed and is currently being used. Initial indicators show that the reliability and performance of the application are within acceptable parameters. Moreover, penetrations testing has not revealed any of the known vulnerabilities that may exist in such systems. Studies show that a major portion of the population feels comfortable learning in this virtual environment, thus increasing their ability to learn. This project also focuses non-functional requirements of reliability, security, and performance. These non-functional requirements are a necessary part of any application. We, in this paper, propose several non-functional requirements that aim to improve reliability, security, and performance of any virtual learning system.

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