E-Learning in Engineering through Videoconferencing

The Case of the Addis Ababa Institute of Technology

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***Abstract*—In addition to their ability to reach distant learners, interactive e-learning environments have the potential to make the teaching-learning process more effective. This paper highlights some of the e-learning implementation efforts at the Addis Ababa Institute of Technology (AAiT) in Ethiopia. This case study shows that limited resources do not deter a developing nation from exploiting the power of e-learning. Based on feedback from participants in the first national videoconferencing program held in Ethiopian higher education system between October 2011 and June 2012, the paper addresses the lessons learned and recommended actions for moving forward to a successful implementation of e-learning in Ethiopia, particularly in a videoconferencing mode.**

***Index Terms*—videoconferencing, online learning, interactivity, learning management system.**

I. INTRODUCTION

E-learning is implemented in various forms including the use of virtual learning environments, interactive multimedia programs, online discussion forums, web browsing and web link sharing tools, course announcement pages, chat rooms and discussion forums, digital portfolios, learning management systems, etc., both for teaching-learning and for administrative purposes [1].

Improved performance of students, increased access to resources, ease of content maintenance, convenience and flexibility to learners with respect to time and place and development of vital skills and competencies for the 21st century including digital literacy are some of the remarkable advantages of E-learning over traditional classroom based instruction [1,2,3].

Ethiopia has invested heavily in higher education with the result that the number of public universities has grown from ten to thirty-three in the past decade. Furthermore, the number of university students enrolled in science and technology fields has been increasing every year. Hence, the Ethiopian colleges and universities face a number of challenges, including the need for well-trained faculty. Thus, more efficient educational techniques must be employed to maximize the effectiveness of the limited human resources and computational facilities.

The following sections present the e-learning efforts at AAiT, particularly the recently-launched national videoconferencing program and its assessment.

II. E-LEARNING PRACTICE AT AAIT

The use of interactive computer technology for teaching and learning at AAiT was in an embryonic stage for many years, with noticeable growth after the first e-learning Africa (eLA) conference, which took place in May 2006 in Addis Ababa. The eLA became an annual event on e-learning, hosted in an African country, with its main focus being investigating and sharing experiences about e-learning in Africa and elsewhere [4]. Prior to the first eLA, the faculty had limited e-learning experience. They provided digital course materials in a repository located on the campus intranet. These materials included eBooks, lecture notes, presentations and the like, that each instructor collected and made available to students taking their courses. The major efforts in the development and implementation of e-learning at AAiT after the eLA conference are presented below.

A. *Training*

A training program on e-learning development and implementation was organized for participants from Africa and Asia in 2006 in Addis Ababa. The course was prepared by specialists from Europe and funded by the German government. The course was a blended learning one with two weeks of face to face sessions arranged both at the beginning and end of a six month online learning component. It included introduction to instructional design, e-learning technology, content development, interactivity, etc. Participants were expected to develop a course module of their own choosing using lessons learned during the training.

B. *Learning Management System (LMS)*

The KEWL.NextGen (KNG) LMS had been installed and used for content creation and delivery at the institute as an outcome of the foregoing training. At the same time, some course modules were prepared and offered in a blended learning mode. After testing KNG for one semester and investigating other LMSs, the Moodle LMS platform was adopted. Orientation was provided to a number of instructors, and user manuals on this platform were prepared both for faculty and students.

C. *Interactive Content*

Despite the infancy of e-learning application at the institute, some interactive content was developed and used because of the need to engage students with the content. In addition to providing lecture notes and other course

materials on the course site, some of the courseware also included a variety of interactive elements such as: glossaries, discussion forums, quizzes, assignments, etc.

D. External Interventions

As a capacity building initiative, an expert from Germany was hired by the Ethiopian government and assigned at AAiT to the task of coordinating the e-learning initiatives. The expert organized a number of training sessions for the faculty on the effective use of various content creation tools. Furthermore, through a similar initiative, digital content was collected from the internet for all of the courses of the institute. This content was organized on CD which was then made available to the faculty. Another major capacity building effort was to equip the institute with videoconferencing facilities, which will be presented in detail in the following section.

III. VIDEOCONFERENCING PROGRAM

Videoconferencing is one form of e-learning that provides live interaction between remotely located students and the instructor. It offers a number of benefits like the ability to reach a large population of distant students while saving travel time and expenses for faculty compared to the face-to-face alternative [5,6]. These kinds of programs have been running for some time at the institute using specially designed curricula by receiving satellite transmissions of courses from IIT, Delhi.

A videoconferencing program together with other e-learning activities was launched to train newly recruited faculty at a number of government universities during the 2011/12 academic year. Accordingly, three of the existing regular post-graduate curricula in civil engineering, namely Structural Engineering, Hydraulics and Geotechnical Engineering, have been offered through the videoconferencing system. The language of instruction is English since this has been the language of instruction in the Ethiopian higher education system since its inception in 1962.

Though videoconferencing is implemented in many forms, the one used in Ethiopia is the TV-type IP based synchronous videoconferencing system in which lectures are transmitted to students at remote locations. This system provides two-way interactions between the instructor and the students. Although the functionality was available, the video transmissions were not recorded in the pilot offering of these courses.

About twenty senior faculty members, mainly from AAiT, have offered courses, and more than 300 students enrolled with the majority of them completed the program through a concerted effort of all parties involved. One faculty member served as the national coordinator of the program. Tutors, who were tasked with assisting the students and the corresponding faculty, were assigned for each course at each of the universities. The faculty, the tutors and the students did not receive any orientation, and guidelines were not prepared for the program in advance.

Unlike the regular face-to-face classes, videoconferencing requires thorough preparation with respect to the content, the technology, the guidelines to be followed, the room-settings, orientation to students, etc. [5]. Though the pilot was launched with minimal preparation, the participants gained a great deal of experience and knowledge about e-learning that will shape subsequent offerings.

In this program, one of the authors has offered two courses – Matrix Methods for Structural Analysis and Finite Element Methods in Structures – by supporting the videoconferencing program with other interactive web content. The author has conducted a survey on sixty students from three of the six participating universities. The purpose of the study was to assess the program and develop a proposal to improve the videoconferencing program.

IV. DATA ANALYSIS

Two of the courses offered in the videoconferencing program were surveyed in this study with the aim of collecting feedback in order to improve the program. A total of 175 students from six universities had registered for the course, and of those, 127 of them completed the course with a final grade. We are not certain of the reasons why the dropout is higher than in the regular F2F program, which is less than 10%. We propose to study the students who did not complete the course in order to understand the reasons behind the higher dropout rate in order to improve future course offerings.

The survey of the students who did complete the course involved 60 students, with about equal numbers from three of the six participating universities. There were no specific criteria for the selection of this group. When asked whether students had any previous e-learning experience, more than 90% answered that it was their first encounter with this type of education.

During the program, the faculty had ongoing informal discussions about problems with the program and what measures would improve the program. Based on this, some questions have been included in the questionnaire to measure the students' agreement with some of the claims regarding the videoconferencing programs. The responses are presented in histograms in Figures 1 through 7, in a scale of 0 (completely disagree) to 5 (completely agree). We see strong agreement across questions except for one related to whether students believed they learned as much in this mode as they would have in a face to face mode.

For a three-credit-hour course, students are expected to spend at least 6 hours/week of study. The survey shows that the students spend on average 14Hrs/week (margin of error = 3Hrs) to study the course outside the lecture, which shows that they spend more time for their study. The survey also shows that 5Hrs/week (margin of error = 1Hr) of this total study time is spent on the internet where students are engaged in the online activities provided along with the course. The total study time and the time spent for online activities are relatively strongly correlated ($r = 0.75$). Time spent on online materials was also highly correlated with total amount of time spent on the course outside of lecture (Cronbach's alpha .75), which supports the view that the online materials were an integral part of their course participation.

The following three questions were all roughly about course structure and were highly correlated with one another (Cronbach's alpha .65):

- The content is arranged in a clear, logical and orderly manner.
- Discussion Forums were useful and relevant for the course.
- Oral examination should be mandatory for this course.

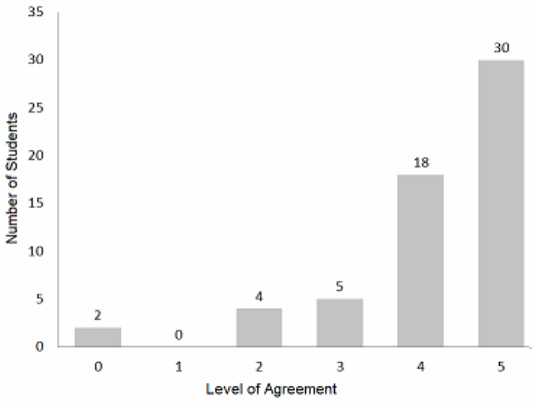

Figure 1. "Online activities were relevant for the course"

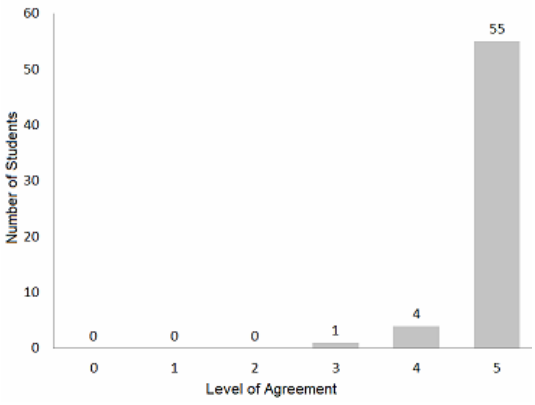

Figure 2. "Quizzes and assignments were essential"

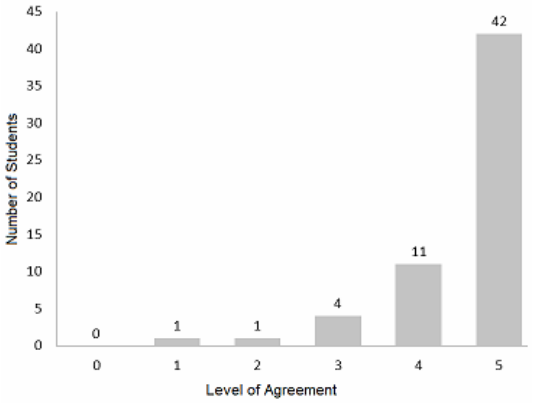

Figure 3. "Discussion forums were useful and relevant"

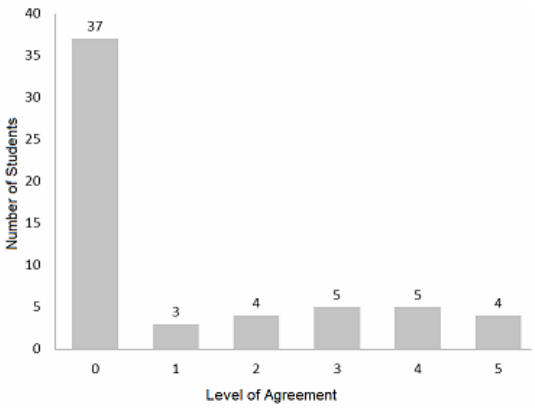

Figure 4. "Tutors were effectively used in the course"

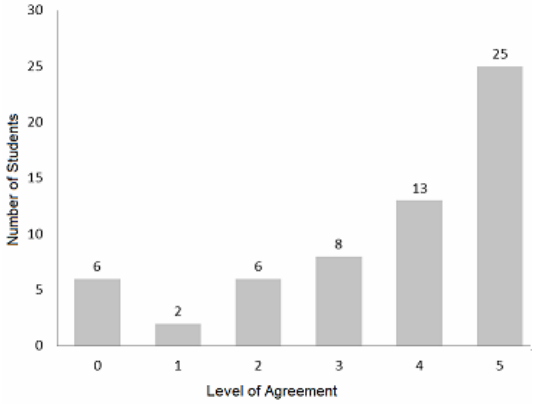

Figure 5. "This course cannot be offered in videoconferencing"

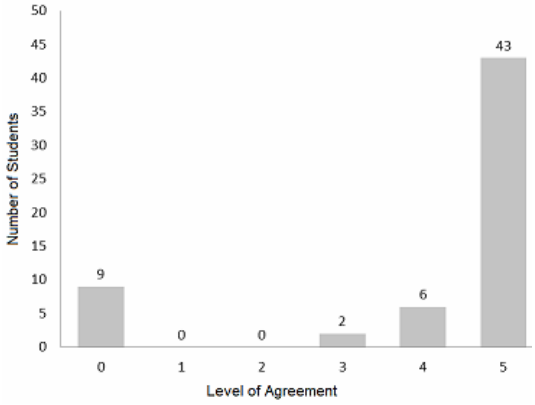

Figure 6. "The video lectures need to be recorded and posted"

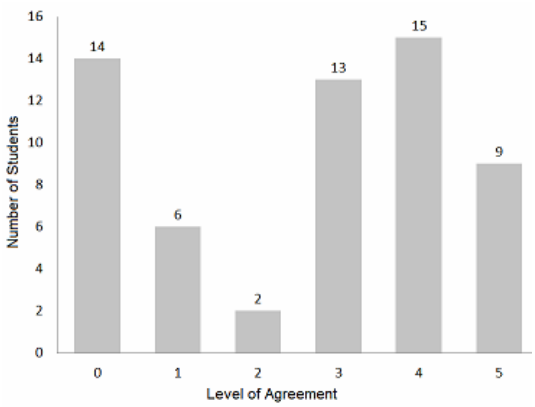

Figure 7. "You have learned in this program better than you would have in a Face-to-Face class"

The average score across these three questions were high for students on average. Specifically, the mean was 4.13, median 4.27, and standard deviation .62. So, on average, students were pleased with the structure of the course, and this did not differ between students with more and less experience with such environments.

As shown in Figures 1, 2 and 3, the students found the additional engaging activities provided outside of the videoconferencing lectures to be very useful. Such activities also provided a means of communication among the students and the faculty and offered the students something of a cohort experience.

The final examinations were consistently in written form and conducted at the respective universities where they were then sent back to the faculty for marking. Tutors

could have played an important role in the program by solving technical problems, answering simple questions that the students faced, and passing information to and from the students. However, this was not the case during the videoconferencing program (see figure 4). There was evidence that students who did not have access to the tutors relied more on the quizzes and assignments, perhaps because they were the primary feedback they received. The effect was highly significant ($p < .005$, effect size 1.14 standard deviations).

Figure 5 shows the majority of the students agree that the videoconferencing lecture should be recorded and made available. The complete disagreement to this by nine students might be a misunderstanding caused by the wording of the question. They may have thought that a recorded video is proposed to replace the live videoconferencing lecture, which is mostly not preferred.

The following are significant points gathered from the questionnaire when the participants were asked to comment freely on the videoconferencing program, identify the problems related to the program, and give suggestions for improvement.

With respect to infrastructure and facilities:

"*Power and/or network interruption during the lecture, tutors unavailable or not giving the necessary help, sound from the lecturer being not clear in the lecture hall, insufficient reference material for the courses and lack of coordination are the significant problems*."

"*The room was so hot and unfavorable for the program especially in the afternoon; we cannot attend the class in a good mood*."

"*Technical problems like the microphone not functioning properly have blocked us from communicating and asking questions during the lecture. Is it possible to make the videoconferencing independent of the internet?*"

"*Videoconferencing is better and more enjoyable than face-to-face learning because it uses animations, precise notes, and the instructors are more serious than they are in a normal class. But connection and other technical problems need to be addressed for the program to be successful*."

With respect to instructors and tutors:

"*Tutors should be well informed about the system and the course so that they provide appropriate help. They shall take some time before the start of the lecture and give important information*."

"*A visit by the instructor to respective universities at least once in a semester would have been a helpful experience. That way, not only the students would have confidence in their efforts, but the instructors can also understand the type of students they are dealing with*."

"*Since the lecture is going so fast, it is usually difficult to take notes. There's also no time to ask questions while the lecture is progressing, so we skip things we don't understand*."

With respect to content and materials:

"*Teaching materials need to be provided both in soft and hard copy, since there are no sufficient reference books at our university. Not all students own a computer, so the hard copy is very essential. It is also better to write live during the lecture rather than displaying PowerPoint presentations and speak about that.*"

"*The videoconferencing lectures should be recorded and made available later; once missed, it is missed forever*."

"*Without the activities, it would have been difficult to understand the course. Giving assignments and quizzes is good, but providing their solutions afterwards is equally important*."

V. DISCUSSION AND RECOMMENDATIONS

The main issues to be addressed in order to properly implement e-learning especially using videoconferencing are presented in this section. This is based on the lessons learned from the efforts made to date at the AAiT, the feedback from the participants of the first national program, the practices of universities in USA and other related publications.

A. Infrastructure

Though the power problem seems to have recently been alleviated nationwide, electric power outages have repeatedly disrupted the videoconferencing program in the past and rendered it unable to conduct all e-learning activities. Power and/or network interruptions were the dominant challenges faced by the program. The majority of communication problems are directly or indirectly linked to power failures. No respondents mentioned lack of computers as a problem, most likely because these students are already employed and have their own personal computer or laptop. However, we know there is a shortage of computers and computer labs on the campuses especially for undergraduate students.

Proposed Actions

Computing resources in the universities are limited compared to the number of users leading to overcrowding of the computer labs and slowing down of the network connectivity. Additional computers and computer labs should be provided and the networking facilities improved at the remote sites.

Videoconference lectures should be prerecorded and made available on the course website. Prerecorded lectures serve as a backup in case either the main site or a remote site suffers a power or network outage during the live course.

B. Content

Videoconferencing classes require more content preparation than face-to-face sessions. As learned from the survey, content with rich interactive elements is vital for the successful delivery of a course.

Proposed Actions

Interactive content needs to be developed for each course. Discussion forums, quizzes, assignments and project work could be easily implemented on the campus learning management system. However, not every component of a course needs to be developed from scratch. A number of course nuggets (video clips, audios, lecture notes etc.) are available on the internet which could be linked to the appropriate section of the course for reuse.

Prerecording the lectures not only alleviates problems caused by outages, it also enables students to study the material beforehand and come prepared for interaction in the live session.

C. *Instructor Training*

To teach using new technology requires skills that can only be mastered though practice.

Proposed Actions

Training must be organized for instructors and tutors on the technical issues of the videoconferencing system, on the use of the LMS, on the various content development tools and on the use of interactive contents, etc.

With assistance from the Fulbright scholarship program, an interactive e-learning content is under development by one of the authors for a selected course in the post graduate program. This interactive web based e-learning course can serve as a model for other courses of the AAiT.

D. *Policy and Quality Assurance*

A sound policy and strategy showing the road map for the inclusion of e-learning in the teaching-learning process is essential. This should include duties and responsibilities of stakeholders so that they are committed to the implementation of the program. E-learning initiatives cannot be successful if they are of ad-hoc nature and are based on isolated efforts of volunteers alone. Assessment of the modules and their learning outcomes is essential.

Proposed Actions: The e-learning policy must be well planned and coordinated with a well-established unit that can organize the activities and is responsible for their proper implementation.

Guidelines for evaluation of the e-learning modules are essential, in which minimum requirements like the format of the courseware, the inclusion of interactivity and assessment elements etc. are specified.

The following factors may be used in order to assess the quality of a courseware, including instructional strategies, clarity, coverage, multimedia usage, assessment and consistency of the elements throughout the courseware [7]. This process helps to create a more professional courseware and it also improves the usability of the content.

VI. CONCLUSION

This paper addresses the problems associated with the e-learning implementations at AAiT and provides suggestions for improvement. The main bottleneck was the power interruption that frequently occurred during the program.

It was also shown that, for an effective outcome, e-learning has to engage the learners, and a number of interactivity elements should be incorporated in every courseware offering.

The results suggest that successful implementation of e-learning requires planning and dedication as well. Proper training to the faculty is also found to be essential on the technology as well as on the development and use of interactive e-learning courseware.

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