EDUCATION EXCHANGE: FROM INSTITUTION TO INTRANETS AND EXTRANETS

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Abstract: We propose an education exchange that provides distance learning from an educational resource to individual(s) in a developing country. We analyze the prevailing operating constraints of telecom infrastructure of a typical developing country and build our framework upon it. The ideology is to implement an accessible network capable of providing various services termed here as teaching modes. We evaluate such teaching modes and show that proposed e-learning system is scalable as well as adjustable, and can also be implemented in the environment of developed countries.

1. Introduction

Internet and World Wide Web together with distance learning has solved the problems of literacy, created awareness and skilled labor in remote areas of developing countries. The areas of distance learning (also termed as e-learning now) have been researched in terms of interactivity, frame works for e-education and development of e-tools for necessary implementation of learning processes etc. Interactivity (based upon stimulus) takes place in person's mind due to the contents of the media through and within which stimulus is presented[1]. Following this trail of thought, Bates[2] proposed that in educational settings, the interaction does not occur with originator of knowledge but the knowledge itself represented (as tutors, peers, technologists, real or virtual objects and entities) as information. If this interactivity generates a function in the receiver as a part of the same process, then this generates a socio-cultural interaction (if this function contains stimulus as well), and this stimulus chain may continue on the same principle. It has been argued, based on these lines, that we actually interact with textual information rather than creator of that information[3], and this can have two forms – static and dynamic. These two forms are very effective when combined to generate a transaction. The research has thus been generated considerably on this platform of interaction in terms of development of e-framework and technological tools. The authors in [4] reported distance learning over Intranets. For this, they developed software architecture to support a number of students for variety of services. The architecture thus proposed is within Intranets only with huge bandwidth requirements. A framework for e-learning proposed by persons from IBM corporation[5] has primarily been developed for training programs for IBM employees. The proposed learning model is 4-tier including information, interaction, collaboration, and collocation strategies. This proposed framework covers distance learning programs offered by any educational institution; the only area to be addressed would probably be dynamic adjustability of the concerned framework. A number of research papers have been published for the same objective – interested reader is encouraged to references [6-9].

There has been considerable number of e-learning projects implemented in Europe[10]. The countries include UK, France, Spain, Germany, Netherlands, and Portugal etc; where a number of universities have distance-teaching courses. In this paper, we report the development of an e-learning system within campus over Intranet external access is provided through Extranet in a typical developing country. In order to present this specific objective and its implementation, we discuss the conceptual framework development in next section. Section 3 highlights assessment strategy used for such an e-learning system. In section 4, we discuss hardware and software architecture(s) of our proposed system. In section 5, we present efforts for its deployment along with observations; followed by conclusions in section 6.

2. Conceptual Framework Development

In this section, we discuss background environment where such an online system is to be deployed. In order to assess it, we focus on main component – telecom infrastructure. Within such a regulated environment of developing countries, the telecom infrastructure mainly comprises telephone, ISDN, leased lines etc. with average operating conditions. The prices are reasonable for first two categories (telephone & ISDN) of connectivity – leased lines are expensive for individual customers. Keeping currently deployed infrastructure in view, learning modes and their dynamics are to be devised carefully so that reasonable number of students are provided online access to general administrative/academic information and specific supporting course material. Such a system has to provide varying degrees of access for student's maintained confidence into the system. We term that accessible network as an education exchange that provides various educational services versus infrastructure cost. Under this concept, the system to be devised is suggested to support the following modes of teaching:

a) Offline material only
b) Offline material with archived video
c) Offline material with archived video and moderator
d) Offline material with webcast
e) Offline material with online chatting (text, audio etc.)
f) Offline material with web camera
g) Offline material with videoconference

The support for such modes of teaching varies from ordinary telephone connection to a leased line at student's premises. It should be re-emphasized here that the teaching mode varies in quality as we go from offline to online for accessing the teaching material. This is what it seems to be desirable for such scenario providing cost versus quality. In other words, the services to be provided to students depend upon the availability of necessary infrastructure at their premises. Considering different modes of teaching mentioned above, the various services can be differentiated between offline and online teaching modes, as below:

(a) **Online teaching*:***

Web camera sessions; Chatting with module tutor(s); Videoconferencing session(s); Web casts

(b) **Offline teaching:**

Course Information; Lecture(s) in form of presentation(s); Course related material; Tutorials; Simulations; Videos; Small Quizzes for self-assessment; Moderated frequently asked questions

(c) **Extra(s):**

Announcements; Schedule(s)/Tasks; Submission of student's homework; Availability of Grades; Course registration and payment

Although extra(s) material is an offline activity for students, it has been shown separate from teaching modes. Based upon above discussion, knowledge acquisition seems to be variable within different modes of teaching – similar is the scenario with e-related technologies. Using different modes of teaching (mentioned as above), learning domains as well as e-learning technology classes can be drawn as shown in Figure 1. The Figure shows that as we go from offline to online mode, the degree of collaboration increases so does the skills learning and teacher's focus on each student. Further, if we look closer at services versus modes of teaching, the e-frame work to be devised for such a flexible and a wide range platform needs to have internal and external sub-systems. The internal and external sub-systems can be considered as equivalent to registered and un-registered students respectively. Both of these sub-systems of e-framework are to be developed and supported by an online education system within a typical telecom infrastructure of a developing country. Such an e-framework is proposed as shown in Figure 2. The horizontal dimensions of the e-framework are information, interaction, collaboration, collocation, and transaction, where as vertical ones are internal and external. On the vertical side, the external dimension is open to any one interested for information, where as internal dimension is for registered students only. The registered students within Extranets-domain having only telephone lines at their point of contact will be able to use all dimensions on the internal side except some features within interaction and collocation dimensions. On the horizontal side, the interactivity grows from offline to online subject to timely participation of students into the online session and cost borne by them. In the next section, we discuss assessment strategy for local (on Intranets) and remote (on Extranets) students alike.

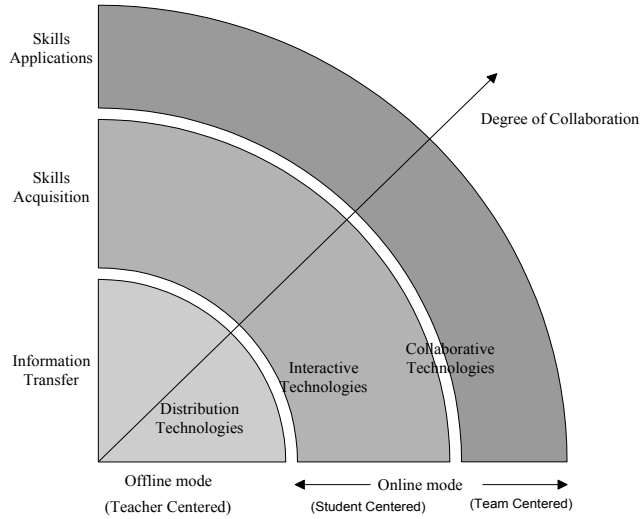

Figure 1. Learning domains versus e-learning Technologies

3. Assessment Strategy

In this section, we propose assessment strategy for scenario under discussion. The strategy includes activity indicators with respect to student's participation in the course as well as performance parameters related to e-learning system for future enhancements and developments according to students' needs. This concept is user driven and based on adaptive learning methodologies. Through experience of a developing country, we observed that students' regular participation or attendance in course driven events and their regular corresponding feedback have produced positive results in terms of their performance in the course and teaching system respectively. Moreover, the registered student might have access to telephone line only, and this may limit their learning activity. Based on these factors, we propose to include progression chart as well as e-learning system performance chart as an indicator of student's continuous interest in the course and that of system performance respectively. The activity indicator chart does include reading of teaching material, student-teacher interaction and assessment of each course unit, and performance indicator chart includes feedback from students

	Information	Interaction	Collaboration	Collocation	Transaction
External	Course specification, Course promotional material, Instructor contact Information, Institutional information		Global chat rooms on course related topics, Usenet and Listserve for student discussions across courses/ campus		Registration, Application forms, Online payments, Transcripts processing
Internal	Assignments, Class bulletin boards, Course notes & presentation slides, Videos, Web lectures	Self-directed learning objects, Interactive games & simulations (CBT/WBT)	Chat rooms, Conferencing boards, Group touring, Whiteboards, Hand raising & other collaboration tools	Mentoring, Class room, Role playing, Case Studies, Expert presentations, Video conferencing	Online assessment, Course support Material, Course assessment & grading, Student performance tracking, Digital library

Figure 2. The e-framework providing access to Intranets and Extranets

and infrastructure-utilization by e-learning activities. The respective charts are shown in Figure 3 and 4 respectively. The Figure 3 shows that activity indicator gives higher weightage to course material contents. The main objective behind this proposition is that the content access is the only factor responsible for generating other two parameters in activity chart and can exist independently, and the fact that the final assessment of the course considers the learning outcomes of contents of the teaching material presented on the e-learning system. Additionally, as far as remote students are considered, they might have access to only information dimension (refer to Figure 2) of the e-framework hence content creation and its organizational representation will play a major role. Student-teacher interaction is suggested to be evaluated by the teacher in order to place fairness between services (including e-learning infrastructure) offered to local and remote students. The progression line shows the depth of activity from simple access to contents to all including interaction with teacher and undergoing through a small set of quizzes/exams for self assessment along the course content tree. The Figure 4 shows three processes proposed as parameters for assessment of complete e-learning system. The rationale behind inclusion of infrastructure utilization is that it delivers the level of information flow and interaction in a course - current state of technological education in a developing country does require frequent exchange between student and teacher and among students themselves so that necessary communication skills, and collaborative/interactive learning skills can be generated within the students. The final and/or mid-term assessment(s) of the course are subject to the specification of the course and can be in the form of attachments (e.g., docs, codes, spreadsheets, diagrams etc.), web forms, multiple choice questions with time-stamped hand-in date. These assessments of the course(s) can be done online via Intranet for local students, except for remote students because of average operating conditions of the telecom infrastructure in a typical developing country. As far as assessment of complete e-learning system (by student) is concerned, a lot of work has been carried out by researchers and we intend to use similar one as proposed in [11] as it addresses all of the dimensions of proposed e-framework. The corresponding form is shown in Table 1. The form targets areas of concern to student's learning like activity usefulness, quality material online, and quality of e-learning environment etc; and can generate useful data for measuring the performance of e-learning system. In order to assess the quality of teaching material online from the perspective of learning-methods-effectiveness-indicator, we intend to measure proposed different teaching modes via the indicators shown in Table 2. The results from these quality measurements (using Table 1 and Table 2) will be discussed in section 5. In the next section, we discuss hardware and software architectures for implementation of such an e-framework.

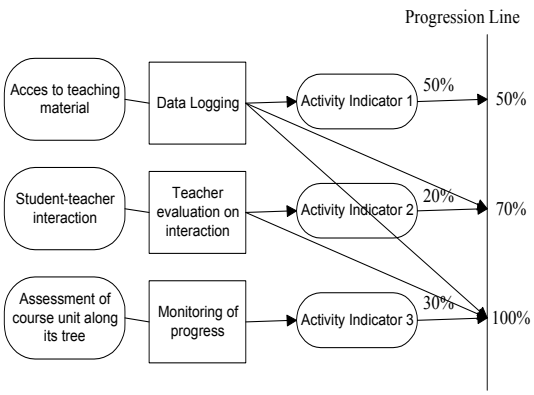

Figure 3. Student's activity indicator on the e-learning system

4. Architecture of Proposed e- framework

The architecture of such an e-framework includes hardware and software alike. The Intranet architecture includes all services on horizontal dimension of the e-framework.

Software architecture: The software architecture is shown in Figure 5. Class information (HTTP) server contains all information related to external dimension of information, and transaction part of the e-framework. Information is static (on teachers and students) or dynamic (on sessions in progress). A separate session control is created whenever a student logs onto the system, and class information (HTTP) server is accessed. The session is closed after information is exchanged. Session control creates and manages all other processes among course web server, teacher's desktop and student's desktop. It also establishes the graphical user interface, creating and managing the main window and smaller video windows.

Hardware architecture: The typical Intranets are Ethernet having 10/100Mbps bandwidth. The hardware configuration of an e-learning system for similar local area networks is shown in Figure 6, and typical layout of e-learning system is illustrated in Figure 7. The student's desktop should have basic multimedia support (microphone, speaker etc), and (optional) web camera installed with connectivity to Intranet, sufficient for access to all services on horizontal dimension of the e-framework excluding videoconferencing sessions. The videoconferencing facility within (classroom) Intranet is provided by host institutions. In case of outsiders (on Extranets) using ordinary telephone line/ISDN or leased line, the desktop system requirements will remain same and are subject to cost versus quality issue. The separation between internal and external dimensions of the e-framework is to be provided by firewall technology. It also provides access layer to Extranets in providing security with the help of passwords, IP addresses and encryption to authorized users. This will also help in establishing the link between HTTP server and corporate databases for transaction processing. These corporate links (for transaction processing of registration, tuition fees etc.) might be

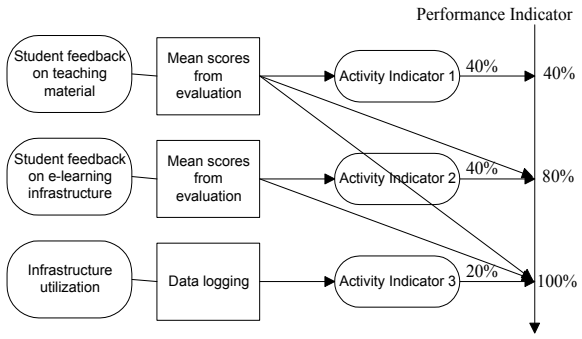

Figure 4. System performance indicator on the e-learning system

required in a typical situation, where online authentication and transaction might not be feasible (due to local business trends). The server requirements are dictated by authentication requirements, number of sessions to be supported, size of students' folders within system, instructor's requirements for providing online answers to student queries, and support of videoconferencing facility to student. The Ethernet network carries site layout and all that is mentioned as services in section 2 including transaction, interaction and information dimensions of the e-framework to the student's desktop.

5. Implementation Details

In this section, we discuss implementation setup based on proposed e-framework, and provide analysis using assessments described in section 3. From financial perspective, the hardware architecture is simple to maintain except that some redundancy on lines/hardware would be required to maintain an online system in addition to some human resources requirements for content development, its organization and infrastructure maintenance. The additional requirements are servers with user licenses, protocol support of HTTP 1.1, IP Multicast, and IRC, allow Active-X controls through proxy/firewall, application support of Java and Macromedia Flash, and access to 80, 23, 21, and other application specific ports. The minimum user technical requirements are Pentium class processor with 32MB RAM, Windows based operating system with Macromedia Flash 4.0 plug-in and Java and Cookies enabled Internet Explorer 4.01 or equivalent, 16 bit sound card, mouse, speakers and headphones, display setting of 800x600 resolution (4096 or more colors) and 56kbps or better Internet connection. For the purpose of online transaction services (as far as financial matters related to remote students are concerned), Institutions can contact remote financial centers to help serve as payment counters for student registration and other related payments. However, it should be emphasized here that selection of such remote financial centers and corresponding arrangement shall not cause a significant delay in student's access to academic material and other related matters. From teacher's perspective once content creation is completed and material is produced online, the teacher is more likely to be involved in individual attention on the student requiring specific answers to questions using hand-raising procedures. There exists a situation when teachers find themselves bogged down in an un-academic rather procedural activity. The impact of this un-academic activity seems directly related to those situations where telephone lines have below average operating conditions.

Looking back at various teaching modes in section 2, we can figure out the effectiveness of different teaching modes using Table 2, and is displayed in section 3. It is clear from Table 3 that the remote students using offline teaching mode (only) will not experience effective learning because of lack of access to the activities of interaction (like discussion groups, chat with teacher etc.) and thus the e-learning system is likely to suffer from poor operating conditions of telecom infrastructure of developing countries. The range of effectiveness versus teaching mode(s) shown in Table 3 depends upon quality of teaching material, its representation, and quality of interactivity. The student's assessment form (for quality of e-learning system using Table 1) statistically collected through various experiments and supported by institutional systems like those of Figure 3 and 4 can be used as a benchmark and compared with Table 3 to assess the position in the respective range. It is also clarified here that availability of various teaching modes makes this e-learning system scalable as well as adjustable, hence it can be transported towards the environment of developed countries, where as a result of implementation, the less interactive teaching modes are likely to disappear and highly interactive modes will be universally available. Obviously, the design of such access systems depends upon conceptual layout of various services to be offered online through an academic institution.

6. Conclusions and Future Directions

We proposed an e-learning system over Intranets and Extranets. We showed that the e-learning system within a developing country would have different teaching modes available to the student depending upon respective telecom infrastructure. We discussed different assessment procedures and indicators for effectiveness of such an e-learning system. We found that the success of proposed e-learning system within a developing country depends upon conceptual layout of various services with their corresponding success factors, and their better content representation. As a remedy to relatively lower effectiveness of certain teaching modes, the institution may opt the delivery of course specific teaching material on CDs in case of problem specific areas and/or making teaching material available on geographically located servers for relatively easy access. Alternatively, the institutions may provide voice mailboxes to teachers to support interactivity with remote students. The future trend towards addressing of such scenarios would be better content creation and organization using new multimedia tools with emphasis on self-paced learning, implementation of asynchronous learning and date profile-based content.

Survey Item	Strongly Disagree	Disagree	Neutral	
Quality of teaching material				
Course Expectation				
Quality of material				
Quality of discussions				
Quality of feedback				
Quality of assessment				
Course structure and format				
I would take another virtual course				
I would recommend this to my friend				
Overall satisfaction with the course				
Quality of e-learning system				
Asynchronous learning				
Self paced learning				
Learning flexibility				
Online discussion boards				
Chatroom discussions				
Ability to communicate with others				
User Interface				

Table 1. Assessment form for quality of e-learning system

References

[1]. R. Anderson and P. Pearson, "A Schema-Theoretic View of Basic Processes in Reading Comprehension", *Handbook of Reading Research*, New York, 1984.

[2]. A. Bates, *Technology, Open Learning and Distance Education*, Routledge, London, 1995.

[3]. Y. Karaliotas, "Interactivity in the Learning Environment", A Project Report published by British Open University, 1998.
[4]. K. Maly, A. Hussein, C. Overstreet, J. Wild, A. Gupta, A. Youssef, E. Stoica, and E. Al-Shaer, "Interactive Distance Learning over Intranets", *IEEE Internet Computing Magazine*, pp. 60-70, January 1997.
[5]. "*E-learning: Implementing 4-Tier Blended Learning Model*", IBM Mindspan Solutions white paper, November 2001.
[6]. T. Boyle, *Design for Multimedia Learning*, Prentice Hall, London 1997.
[7]. L. Porter, *Creating Virtual Classroom*, New York, 1997.
[8]. C. Perez et all, "Enhancing the Performance of a Virtual Campus for Higher Education: Impacts and Achievements", *Proceedings of EDEN'98*, Italy 1998.
[9]. S. Brofferio, "A University Distance Lesson System: Experiments, Services, and Future Developments", *IEEE Transactions on Education*, pp. 17-24, February 1998.
[10]. M. Castro et all, "Examples of Distance Learning Projects in the European Community", *IEEE Transactions on Education*, pp. 406-411, November 2001.
[11]. L. Motiwalla, "An E-education Framework For Training in The Next Generation Enterprises", *Technical Report* submitted to College of Management, University of Massachusettes, Lowell, 2001.

	Category of Learning	Effectiveness
1	Lecture	5%
2	Reading	10%
3	Audio Visual	20%
4	Demonstration	30%
5	Discussion Group	50%
6	Practice by doing	75%
7	Teaching others	90%
8	Immediate application in practice	90%

Table 2. Learning Methdos Effectiveness Indicator

	Teaching Mode available through e-learning	Effectiveness Range
a	Offline teaching material	30%
b	Offline material with archived video	30%-35%
c	Offline material with archived video and moderator	30%-55%
d	Offline material with web cast	30%-35%
e	Offline material with online chatting (text, audio etc.)	30%-80%
f	Offline material with web camera	30%-80%
g	Offline material with videoconference	30%-80%

Table 3. Teaching Methdos Effectiveness Indicator

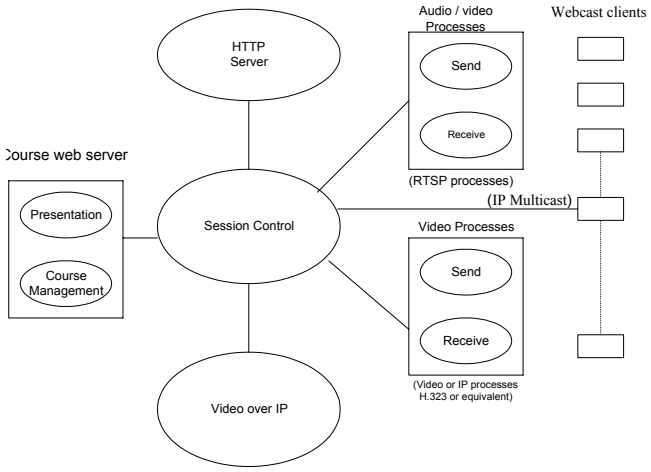

Figure 5. The software architecture of proposed e-learning system

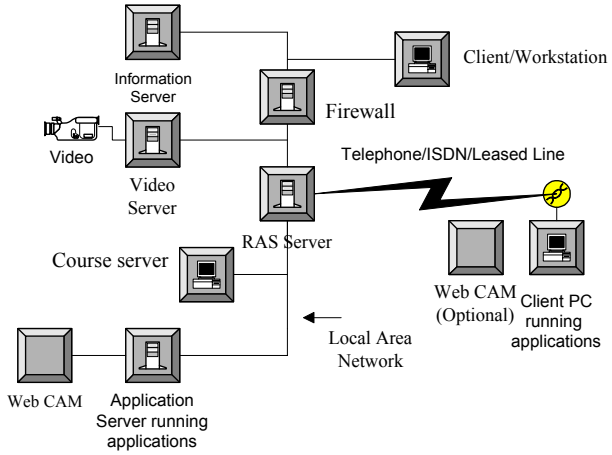

Figure 6. The hardware architecture of proposed e-learning system

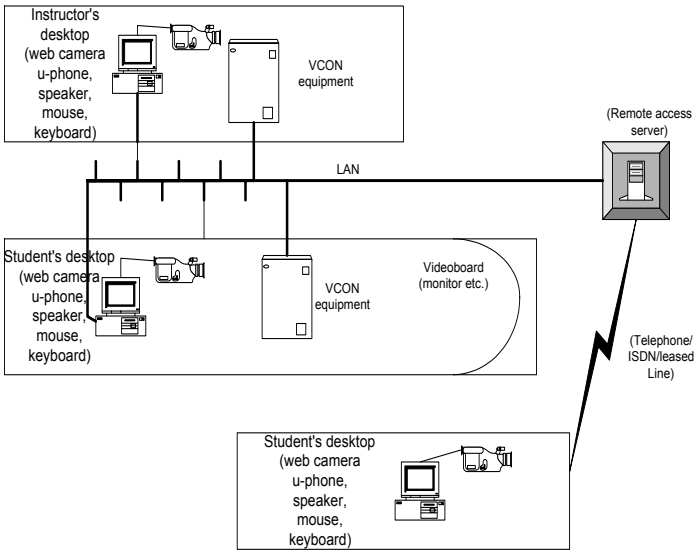

Figure 7. The typical layout of e-learning site