

Towards an Internet-Based Education Model for Caribbean Countries

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Introduction

Advances in the development of the Internet infrastructure and associated technologies can potentially be used within developing countries to enhance the delivery of high quality education to their citizens. The delivery of educational materials over the Internet is now almost commonplace in some of the more affluent developed country. The mechanisms range from the very sophisticated *Virtual Classroom* (VC) in which students in cyberspace interact in near real-time with instructors at remote sites, to the more basic non real-time delivery of lecture contents to remote students. The cost of developing sophisticated VCs may be beyond the means of most developing countries, but, as discussed in this paper, less sophisticated VCs can be cost-effectively developed for use in developing countries, and their use can bring about significant changes in the quality of education delivered to students.

Essentially, a VC consists of, (1) educational materials on the Internet via the *World Wide Web* that are accessible by students who have access to the Internet, and (2) mechanisms that support interactions between instructors and remote students. The main motivating factor for considering VCs is the capability to provide consistent quality educational materials to students across a wide geographical area, in a timely manner and with minimum manpower. In Caribbean territories where the concentration of high-quality teachers and teaching facilities are in and around urban cities, VCs can be used to enhance the accessibility of education materials, experiences, and facilities provided at the urban centers by students in more remote areas of the countries.

The technological challenges, while significant, can be overcome by making use of low-cost alternative technologies in innovative ways. An example of innovative use of low-cost technology to provide Internet services can be found in Haiti as described in, Peha (1999). Because of the mountainous terrain in Haiti and the comparative high cost of laying land lines the providers of Internet service have exploited the use of wireless communication, which is intended for cellular telephone service, to provide Internet connection to their customers. In territories, such as Barbados and Jamaica, a different, more centralized approach is taken to address the problem of providing a broad-based telecommunication service to users.

The Jamaican telecommunication infrastructure

The sole provider of voice telecommunication services in Jamaica has established a “Broadband & Bandwidth Service” (BBS) business unit, whose mission is to respond to the increasing demand for services, which require higher bandwidth. Such services include video conferencing, distance learning, television transmission services and the integration of voice, video and data over a single transmission medium. In order to meet their goals the BBS unit is following the trend of deployment fiber optic, rather than copper wire, as the transmission medium. There are four functional areas of the BBS services:

- ✍ Television transmission services, which involves the facilitation of the transmission and reception of television signals via satellite antennas.
- ✍ Public broadband access network, which is a fiber optic based network used to transport high-speed data and video signals.
- ✍ Private broadband network is similar to the public version but is designed to satisfy the specific needs of particular customers.
- ✍ Narrow band service is specific to the provision of video conferencing and distance learning, which is implemented using the company’s expanding ISDN network.

Jamaica has the telecommunication infrastructure needed to support a reasonable sophisticated virtual classroom. A significant factor in determining the viability of such a system in Jamaica is the cost of services provided by the BBS.

The Barbados telecommunication infrastructure

The Barbados sole voice telecommunication provider has established an International Database Access Service (IDAS), which allows the rapid transfer and access of data internationally. This service has two options: a modem dial up facility, through the public exchange; and a dedicated lease line option for corporate users. In addition, the leased line option offers two way communications.

In Barbados international telecommunication access can also be obtained via satellite, microwave and fiber optic facility, which forms part of the sole voice telecommunication provider Global Digital Highway system. Coupled with this system is the Barbados based Internet gateway, which provides Internet-related services to the Eastern Caribbean islands of Grenada, St. Vincent and the British Virgin Islands.

The Ministry of Education and Culture (MEC) of the Barbados Government embarked on a major project, the EduTech2000, to transform the way in which education is delivered to its primary and secondary school students in the late 90s. The EduTech 2000 project, see CCTA (1997) offers a good platform for a VC, with its local area networks (LAN), Intranet and Internet servers. The feasibility study for the EduTech 2000 project examines a number of issues, which are crucial to the viability of a VC program, and presents some very economic solutions. Some of these issues are discussed in a following section.

Paper overview

In this paper we present models of VCs for primary and secondary schools in Caribbean territories, based on a VC called VCOIN (Virtual Classroom Over the Internet), developed at Florida Atlantic University, (see Hsu and Patel (1996) and Hsu, France and Grant (1998)). We describe three variations of VCOIN, which offer different levels of VC services. These models seek to leverage the use of alternative low-cost communication medium in the development of VC environments that encompass institutions in remote rural districts.

The VCOIN is based on research in the areas of video-on demand, Little (1995), multimedia conferencing, see Min (1998) and Internet Protocol (IP) multicasting, see McCanne (1999). The underlying

communication architecture for VCOIN is the distributed client/server model. The client/server architecture provides the flexibility of accessing multiple servers on multiple platforms in satisfying a single client request.

Virtual classroom model

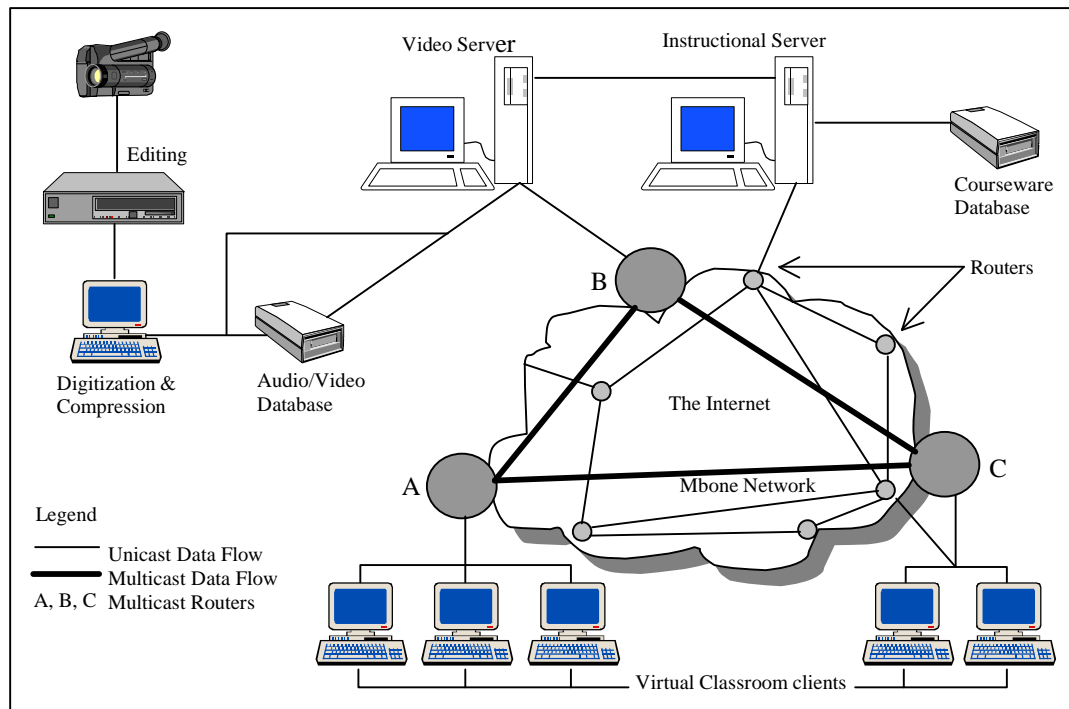


Figure 1: Virtual Classroom Model, Hsu, Pandya & Patel (1998)

Figure 1 depicts the VCOIN architecture. Clients (e.g. students, instructors at remote sites) access files from file servers over the Internet and such requests usually results in the document being transferred from the server to the client application, through a Web browser. There are two types of servers in the VCOIN model; the *Instructional Server (IS)* and the *Lecture On-Demand Server (LOD)*. The IS is designed to efficiently deliver small hypertext documents and associated graphic files and the LOD server delivers audio/video (multimedia) streams. VCOIN incorporates a unique feature, *Centralized Mouse Control (CMC)*, which facilitates instructor control over the session's participant's access on the Internet. Techniques for synchronizing audio and video data when transmitted in compressed format over a network, as in VCOIN, are described in Ehley, Ilyas and Furht (1995).

The Figure 1 configuration of VCOIN includes software for course navigation, virtual experimenter, chat-board, centralized control for student activities, scheduler for conferences, Internet browser, data compression/decompression and transmission, data editing and digitization database management and network management. The hardware includes, video cameras, video/audio editing equipment, video projectors, file servers, workstations, external storage devices and the communication network. Such a sophisticated configuration may prove to be too extensive and expensive for many situations in which it is desirable to implement a VC system, particularly in Caribbean territories. To address this challenge we define families of VCOIN variant that support less expensive use of VCs. These variants are structured into three levels, with Level I reflecting the most basic (thus low-cost) variants and Level III reflecting the more sophisticated variants.

Level I configuration

In a Level I VC configuration there is no video or audio features and users (students) have access only to course material from the courseware database through the IS. This configuration requires that the local instructors, at the remote sites, be provided with materials that guide them through the online course material. A Level I configuration uses low cost client (student/instructor) workstations, since there is no need for advance features to handle delivery of multimedia materials such as video/audio files. On the server side, there is only the need for database management and course experiment management software. This results in a lower data transfer demand on the required network infrastructure, which facilitates the use of low cost, dialup telephone links and eliminates the need for a more expensive Mbone type connection. Remote students participate from a physical classroom environment in the Level I configuration.

Level II configuration

In a Level II VC configuration there are video and audio features from a LOD, along with course material from the IS. The video is delivered from pre-recorded instructor presentations via digitized compressed multimedia files residing in an audio/video database. This configuration requires the use of high-end workstation with multimedia data decompression hardware and software. Both large main and video

memory requirements must be met in order to process the uncompressed audio/video files. The communication network should be medium- to wide-band to facilitate smooth transmission of the files. A low-speed narrow-band (dialup telephone line) may be used because the client session is non-interactive and replaying of sections of the lecture may occur. In the Level II configuration remote students may participate from a physical classroom or home environment.

Level III configuration

The Level III configuration is the most sophisticated of the VC models and includes all the features found in a Level II configuration along with interactive multimedia and chat-board. In the Level III VC configuration multimedia conferencing takes place between the clients and the instructor. Live video/audio from the instructor site is transmitted, along with course material over the Internet to clients. The Level III configuration incorporates Floor Control Mechanism (FCM) and Centralized Mouse Control (CMC) as optional features. The CMC allows the instructor to control what the remote students are doing on their computer by informing the instructor of the positions of the remote students' mouse cursors on the computer screen. The FCM is used to allow proper usage of a shared resource, such as an audio channel, thus preventing incorrect sections of an audio or video file being sent to a remote client. These features add to the performance and control of the system but are not necessary components. Like Level II, Level III clients may participate from a physical classroom or home environment, but if participating from home the clients have to ensure that they log on at the specified time (as the instruction is live) and also have the necessary client based software to participate. In a Level III configuration, communication between the COD server and clients, IS server and clients are both asynchronous and synchronous.

Table 1 compares the three VOIN configurations.

	Video Audio	Local Instructor	Course Experiment	Home use by student	Instructor Control	Student/Instructor Communication
Level I	none	necessary	yes	no	no	none
Level II	pre-recorded	not necessary	yes	yes	partial	one way
Level III	live	not necessary	yes	special ime	yes	two way

Challenges to implementing virtual classrooms

There are many challenges to be faced in implementing a virtual classroom over the Internet. In this section we focus on some of the major issues as they relate to the Caribbean territories.

A major component of the infrastructural cost of setting up an Internet VC is related to establishing the communication network. Computer networking, which is the backbone of the Internet, was grafted onto the telephone network system in the United States, when the Internet was introduced into the public domain. This was done because of the availability of a very extensive phone system, see, Mueller (1999). With the exponential growth in the number of Internet users, see Petrazzini and Kibati (1999), the capability of telephone companies to satisfy the demand is being exceeded. The ratio of persons per telephone line in the Caribbean varies between 2.3 in the Bahamas to 150 in Haiti. Barbados has the next lowest ratio at 3, and Jamaica, the largest English speaking island, is at 12.3 (see Farrell (1999)). By comparison the United States has a ratio of 1.5. The challenge of a suitable telephone system in the Caribbean is further compounded by the following (1) telephone service providers in the Caribbean territories are monopolies and (2) quality service is highly concentrated in the urban areas of these territories. Lack of competition in providing telephone services has resulted in artificially high charges in some regions. The limited telecommunication services available to the rural areas can severely limit the establishment of effective VC services in these areas.

In Haiti the challenge of providing cost-effective Internet service is being over come by making use of low-cost alternatives for delivering telecommunication service. The single provider of voice telecommunication services in Haiti is the state-owned telephone company, but two Internet Service Providers (ISP) have been granted license to provide international satellite data communication. The ISPs have sold some of their services to other ISPs. Because of the inadequacy of land telephone lines the ISPs exploit cheaper wireless communication technology, which was originally intended for indoor usage, so as to provide Internet service to users in areas where land lines are not available, see Peha (1999). In Jamaica and Barbados the single telephone providers have taken a more traditional approach by installing extensive submarine fiber optic cable systems and in the case of Jamaica an earth station with access to an INTELSAT Atlantic

Ocean satellite. Over the past couple of years the Jamaican telephone company began deploying Wireless Local Loop (WLL) technology as part of its strategy to provide basic telephone service at a much faster rate, particularly in rural areas.

The delivery of teaching material over the Internet to students presents a number of challenges for both the instructor and the students. Firstly, instructors are not in visual contact with the students and there is only one-way audio communication, though in a very sophisticated VC configuration students may have interactive video and audio communication with the instructor via individual camera and microphones workstation components. Secondly, students communicate with the instructor via the chat-board, and though some students may be physically in the same classroom they are expected to communicate with each other via the chat-room, as other students may be in different locations. Thirdly, most course material will be delivered to students over the Internet as web pages in a web-browser, as opposed to the usual hardcopy textbooks. These changes in delivery and presentation will necessitate changes in course curriculum, and teaching and testing standards. Training for instructors will have to include multimedia usage, along with on-camera presentation skills, so as to ensure that focus is on the material and not the presenter. Students will also have to be trained in multimedia usage and will have to accentuate their written communication skills. Lastly, both instructors and students will have to be trained in Internet and computer skills such as web browsing and chat-room usage.

Benefits of a virtual classroom

The first and most noticeable benefit from the implementation of a VC is the availability of high quality teaching materials and teaching methodologies to the most geographically remote schools in developing countries. Rural schools, which, prior to using VC technology suffered from the concentration of the best teachers in the urban cities, can now obtain the same material and pedagogical skills which are available to their counterparts in the best urban schools. A second great benefit of VC technology is that a large students/teacher (instructor) ratio can be maintained, yet a greater amount of learning can be realized because of the required concentration and attention demand on the student using the Internet as opposed to

the traditional classroom environment. A third benefit to be realized from VC usage is that students will, transparently, develop and expand their computing skills as a side effect from using the system.

The benefits associated with the implementation and usage of VCs are not limited to the improvement in the quality of the students' learning environment. Territories, which adapt such innovative approaches to the delivery of classroom materials, stand to gain from a graduating population, which is equipped to participate in a telecommunication dependent global economy. The Internet is now available in almost all territories of the world, and it not only offers a medium for academia to communicate and collaborate on research matters but also has become the backbone for many commercial and legal ventures. The birth of commerce over the Internet has spawned a new type of multinational corporation whose business is electronic commerce (*e-commerce*) centric, see Riggins (1998) and Nwana (1998). This "new business focus" need for electronic connectivity across geographical boundaries is so intense it is pushing governments, Internet Service Providers (ISP) and telecommunication companies into reshaping the manner in which international business is conducted, see Petrazzini and Kibati (1999), Cohen (1999) and Mueller (1999). A society whose work force has been schooled in the use of the tools of this "new business" is better able to participate in the new international business arena: this is probably the greatest unintentional benefit for the Caribbean territories who implement VC technology.

Conclusion

In this paper we have presented our model of a virtual classroom over the Internet, VCOIN, which is geared to primary and secondary schools and describe how its implementation may be tailored to the specific needs of the Caribbean territories. Three levels of families of VC have been presented, from which an organization may select the particular configuration that is best suited to their environment. We have examined some of the challenges, which would have to be overcome in implementing a VC, and identified some of the benefits that can be realized. It is our conclusion that the implementation of VC technology, at the appropriate level, will not only enhance the learning and teaching skills of students and teachers but will also aid the nations in preparing themselves to participate in the expanding and evolving electronic-based international business market.

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