EXAMINING MULTIPLE TECHNOLOGIES FOR WEB-BASED TEACHING, LEARNING AND IMAGE ACCESS

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ABSTRACT:

The advent of Internet-based learning management systems [LMS] has greatly simplified the staging of teaching and learning activities to the World Wide Web [WWW]. The increased access to and utilization of the WWW with these LMS has made it easy to accomplish routine teaching and learning activities, but it has also complicated the implementation and use of more sophisticated Web-based activities due to the inherent rigidity of the LMS application as provided by vendors. This project deals with the challenges and creative solutions that have been implemented at our institution to facilitate the access to a wide range of data sets, media and learning tools through our LMS, Blackboard version 7.2 [*www.blackboard.com*]. The presentation will give the details of our approach to the solution, the lessons learned and directions for future development. The challenges in LMS integration were basically four; how to adapt and stage large volumes of digital media for viewing, how to enhance communication with students, how to assess learning and how to acquire and allow easy access to near-real-time MODIS imagery.

1. INTRODUCTION

Varied styles of distance education delivery have been evolving at Bowie State University over the last decade. The first courses were meant to meet general education requirements and often used televised content delivered via campus and/or public television stations. These courses fell under the general category of "correspondence" courses since students did have to return assignments to the instructor. Course overhead such as tests and weekly quizzes were handled with physical, in-person “pen and paper” exercises.

Content delivery, due to broadcast scheduling, was very much a synchronous educational proposition using fixed campus or public television schedules, unless the student could tape the program or gain access to a library of tapes which could be viewed at a media center, the library or in rare cases, checked out to view at home. Content delivery improved little over the years, with a few vendors renting video cassette sets or Universities building their own tape libraries. Course management, however, did evolve rapidly in the late 90's, with much of the administrative overhead and assessment taking place asynchronously with homebrew Web sites or commercially available classroom or learning management system packages such as Blackboard, WebCT, WebTycho and others.

A major breakthrough has begun to take place in the 21st century, as both educational content has gone fully digital and Web-based media provision has matured. Now “tapes” no longer have to be digitized, DVD or Video-CD content is available and software to stage digital media to the Web is pervasive. Bowie State University, through funding from the NOAA Educational Partnership Program to the NOAA CREST Project, is utilizing the advent of confluent technologies to provide anytime/anywhere access to content based on digital media of many types, online interactive assessments, real-time and asynchronous communication with instructors and near-real time regional satellite imagery.

The driving force behind the increased emphasis on Web-based delivery of content, course work and other data types has been the promise of improved educational outcomes using the Internet and a need for savings in all aspects of the educational enterprise. In fact, the University System of Maryland has mandated that a significant portion of a student's undergraduate course work be delivered in non-traditional ways, primarily as a way to increase capacity [USM, 2005]. Major efforts in course redesign have paid off with efficiency, cost savings, and reductions in staffing requirements while maintaining a product that is "not significantly different" from face-to-face instruction [Neuhauser, 2002;Twigg, 2003].

Although the bulk of the effort of this project was the aim for increased efficiency and more convenient access for the student, the author had recognized that technology could serve many of his teaching goals as well as accomplish some that were difficult to deliver in the standard lecture and laboratory mode. As an example, many projects had shown the effectiveness of remote sensing education with WWW tools [Foresman et al, 1997] as well as using Web delivery for classroom educational materials and objects [Johnson, Ruzek & Kalb, 2000]. This kind of education had the very real advantage of anytime/anywhere access for students. Additionally, with a considerable amount of extramurally funded research on campus, there was also a need for effective public education and outreach that could realistically be delivered in no other way than through the World Wide Web [WWW].

With the goals of increasing effectiveness of delivery, improving educational outcomes and providing access to near-real time regional satellite imagery, this project has been in a process of continuous improvement for approximately six years. This time span has also coincided with the growth of support for Web-based education from an individual effort utilizing hand-coded html scripts to a campus-wide institutionalization of online and distance learning within a division of Academic Computing with access to instructional designers and modern learning/classroom management software. In order to facilitate the orderly creation and management of online and distance

learning [OLL], Bowie State University has also developed corresponding policy for the BSU OnLine enterprise, the delivery mechanism for OLL. The challenges, approaches taken, methods adopted and progress made are discussed in the rest of this article.

2. METHODS

The challenges to effective and efficient provision of education across the Internet were, and continue to be, many. In some cases the Internet may have initially seemed to be an example of a solution looking for a problem, and remains as such for many faculty members, but they are becoming less of the majority. Most instruction is still delivered in a traditional way, with fixed fifty minute lecture periods several times a week with longer laboratory periods for courses where they are required.

However, for many types of instruction and/or facets of education, the Internet, even prior to the advent of sophisticated learning/classroom management systems, was an ideal means for allowing asynchronous access to content and to facilitate communications. Probably the earliest adoption of Internet technologies was email; broadly accepted and heavily utilized by students, faculty and staff. However the use of the Internet for distribution of content and multi-media was slow in starting, due in part to the low bandwidth of most connections until recently. The need, the approach and the solutions tested for each of our project areas follow.

2.1 Adapting & Provisioning Digital Media

Initially the bulk of educational content was delivered principally through lectures and textbooks. Some courses used other sources of content, such as archived films, tapes, television or other media and even field trips. Many of the distance learning courses that have historically been in use on campus have a heritage of having been "television" courses, wherein large portions of their content had been delivered traditionally by public or University television stations. This mode of delivery in not much more convenient for students than a face-to-face course, since the content is delivered synchronously and they have to "be there" receiving content at a fixed time. However, this educational mode can be used to reduce classroom space needs, since content is delivered "off campus".

Pre-LMS Course Automation: In this project the original course that was modified was a general education service class in marine sciences, using content from the INTELECOM *Oceanus* Television series, a Study Guide that summarized the media content and linked back to chapters in a supplemental text book. The television shows were broadcast on campus and via Maryland Public television, with tape copies available for viewing in our Office of Media Operations. Students did not attend face-to-face classes, instead being required to watch the video and submit a paper-based quiz once a week.

The challenges of this early course format were access to content, communications, quiz distribution, quiz collection and grading and course exams, to name a few. Students had to watch the video at a certain time, or have a means to record it. This posed problems with adherence to course requirements. Many students missed the broadcasts or otherwise failed to view the content. There was no means of communication with students other than U.S. Mail or office hours. The students could, however, email the instructor, although the instructor had no means of getting the students email addresses. Quizzes were copied into a booklet and sold with copies of the answer form in the bookstore. Only pre-printed commercial quiz answer forms could be used and these had to be distributed to students. Quiz answer forms were turned in to a central "box" weekly and then run through a Scantron reader, with scores manually entered into a spreadsheet. Problems were many, mostly "unreadable" forms that had been mutilated or filled out with pen instead of 2B pencil, plus the manual data entry and face-to-face midterm and final exams for 125+ students.

In this timeframe [1997-2000] Bowie State University had no LMS. So all solutions had to be based on development of in-house html Web pages. Early on the Web was used to post the course syllabus, test/quiz bank, and contact information for the instructor. About the only later advance was use of PDF for materials distribution to assure printing. This project did support some beta testing of the digitization of the entire *Oceanus* VHS tape set [13 hours] which were staged to a campus server and made available though a URL link with the RealNetworks Helix Streaming Server.

Digitization was accomplished with a Dazzle device. Encoding was into Real format, which could be viewed with RealPlayer. This provision of streaming media only lasted one year, and was never fully adopted by students. Most did not have high bandwidth Internet connections so could not visualize the streaming service. The other factor that caused discontinuation of streaming service was the expiration of the free Helix license. The licensing fees were too high to be supported by the University at the low level of use.

Other improvements made in this pre-LMS time included the utilization of the TeleForm software to create scanner-ready exam forms that could be read directly into a database. This was a major step forward, as an image of the form, in PDF, could be distributed, and the TeleForm program was relatively insensitive to damaged forms, as it had registration points that made up for distortion in the form. The direct read-to-database and automatic correction speeded grade book management.

Post-LMS Course Automation: In 2001 Bowie State University licensed the Blackboard Learning Management System. This purchase proved to be a major change in how much of the business of distance and online education was done on campus. Additionally, the campus licensed the PeopleSoft Student Information System, which eventually led to full automation of course creation and student enrollment in the LMS. With the adoption of an LMS, many of the challenges disappeared. Communications was eased since the LMS had a communications module with an email data field that could be self-populated by students, although some would fail to do so, and "enrollment" in the LMS course shells was not automatic.

The LMS could also do assessments, so no more need for paper distribution of quizzes, or for their correction. Due dates and staging could all be done within the LMS, although software tools such as *Respondus* eased assessment creation and *Study Mate* allowed for interactive Flash educational objects based on quiz content. Students still had to watch the *Oceanus* content on television at fixed times since we no longer had a streaming server solution.

There were some other incremental improvements at this time. The author continued to research streaming media solutions. With the advent of Windows Server 2003, the Media Services

capabilities became widely available at not additional cost on many servers. Various beta tests of Windows Media Services for streaming and the use of the Windows Media Encoder to produce multi-bandwidth streaming files proved positive results. Thanks to NASA funding a Windows-based server was acquired to house and serve the streaming media. This server was located "outside" the University firewall in a facility that held the Apple XSEED 224 node G5 blade supercomputer. Also at this time a new version of the marine sciences content, called *Endless Voyage*, and was made available by INTELECOM to replace Oceanus, which had been produced in the early 80. The course that used this content, BIOL203, was made unavailable for one semester [Spring 2004] to allow digitization of its content and integration of the streaming media server with the LMS.

Digital Approach: To facilitate the anytime/anywhere access to the *Endless Voyage* content, we have taken a fully digital approach, where content is converted to a multi-bandwidth streaming media format, and then staged to a streaming media server for access via the Web through links in the LMS. The streaming media service has the great benefit of active communication between client and server, delivering the optimal content bandwidth according to the user's connection speed. High speed connections have a higher delivered frame rate and frame size compared to that of slower connections, but audio quality is preserved across all connection speeds. We have found that students have high speed connections at home or at work, where they view content. Some students still use standalone DVD's of *Endless Voyage*, available for purchase or rental.

In our particular case the content sources were by-in-large from public television tapes, in both analog and digital formats. In the case of the analog tapes, they were digitized with a Matrox IEEE1394/Firewire digitizer, then converted to Windows Streaming Media files with Adobe Premier editing and encoding software. Digital content only needed to be edited and encoded. *Endless Voyage* first released with VideoCD's with low quality, hence the need to use fully digital media once available. In the second year *Endless Voyage* was available with DVD's and digital broadcast tapes, made available by Maryland Public Television [13 hours in 26 thirty minute episodes].

The LMS served another purpose required by licensing agreements: the shielding of content from unauthorized users. Due to licensing requirements we needed to meet stringent digital quality requirements and also had to prevent anyone from using the content that had not paid a license fee. We used campus Blackboard system for authentication, and built simple html pages listing course quizzes and URL links to related Endless Voyage content on media server. Clicking a link evoked the Windows Media Player on a user's computer and began to play the media. The user can move back and forth within the media, stop, rewind, pause and navigate as if the file was local, using the usual WMP tools, but files cannot be saved.

The Digital Content Production Process:

Goal **-** Provide anytime/anywhere environmental course media content to enrolled students [assuming Internet connectivity]

Challenges **-** hardware for hosting & serving media, acquiring content, producing "shows", conversion to streaming media, 24/7 anywhere Internet access

Approach **-** has several discrete components: technology, acquisition of content, content conversion, production, and Web staging

Technology **-**

Needs - "production" and encoding computer, streaming media server, storage, secure Internet access from on- and off-campus

Solutions - ***production & encoding*** **-** dual-processor AMD 64 bit system with 2 GB RAM, three disk drives X 100 GB SATA; ***streaming/Web server*** **-** Sun V20Z dual processor AMD 64 running Microsoft Windows Server 2003 operating system with 2 GB RAM, 400 GB of hard disk storage, Fiber Channel interface to 1 TB of Apple XServe RAID, two GB NICs for rapid network input/output and failover capabilities; ***additional storage*** **-** SnapServer 4500 NAS with ca. 600GB RAID 5 storage space; ***Internet access*** **-** independently fire-walled location within BSU XSEED supercomputer room "outside" campus. All Web services and streaming media are run through Windows Server 2003.

Acquisition of Content **-**

Needs – digital content for Endless Voyage, a 26 episode X 30 minutes marine environment course from INTELECOM.

Solutions - prior to distribution of digital tapes Endless Voyage analog tapes were digitized from a 3/4" tape deck with a Matrox digitizing card in our production computer. In 2006 digital files were provided under INTELECOM license by Maryland Public Television. These were used in full production due to higher image quality.

Content Conversion –

Needs - Media Services in Windows Server 2003 requires “Windows media files” for streaming. Endless Voyage digital content distributed as DVD-format “vob” files that can only be "played" and are incompatible with streaming software.

Solutions - convert "vob" into standard MPEGS with an “avi” audio track by demultiplexing with DVDecrypter; reproduce audio and mpeg into a file compatible with streaming encoder with Adobe Premiere Pro 2.0; encode into a multibandwidth Windows Media file with Windows Media Encoder. Final streaming media files encoded as two streams, a 320 X 240 pixel 25 frame per second [fps] stream for high speed internet users [ca. 200 kbs] and a 160 X 120 pixel 15 fps stream for modem connections [ca. 50 kbs]. Note that “raw” DVD files are about 1.5 GB per 30 minutes run time, but compress to less than 70 KB or less as streaming media.

Production –

Needs - introductory and closing materials for each 30 minute streaming media episode of *Endless Voyage*.

Solution - rather than incorporating introduction and wrap up lead material into each episode as part of the Adobe Premiere processing, the Windows Media Services supports "playlists" that can append media to start and/or end of a "broadcast". The lead material welcomes students to the BIOL203 media and advises that the content may not be recorded and is strictly for use by enrolled students due to licensing agreement. Credit is also given to NOAA EPP for funding support. The final closing remarks thank students for watching and remind them that viewing the content is an important part of the learning process.

2.2 Enhancing Communications

Communications is the key to successful research, program management and the delivery of effective and fully online education. For research or programmatic processes, frequent group discussion, often among participants at different

locations, is required. Telephone communication may work, but distant seminars are difficult to promote and utilize. In the NOAA CREST Project there are frequent seminars and NOAA-related meetings that are meant for the broadest attendance, even though there are five geographically disjunct Universities and several NOAA facilities involved.
In terms of education, the fully online model lacks the very useful multi-weekly face-to-face contact of traditional education delivery. The lack of face-to-face contact is often detrimental to success as less well-organized students may miss key assignments and/or deadlines because they fail to make note of the information. Although information is easily pushed to the students by campus email, many do not use their campus accounts or may not set up the forwarding to other, more used accounts.

What was Tried: Other communications means we sought beyond email and telephone. For the research seminar or meeting, the streaming media server approach was used, but instead of static content, the Windows Media Encoder was used to capture the seminar with a digital video camera plugged into the USB or FireWire [IEEE1394] port of a laptop in the seminar room. The Media Encoder was set for a "pull" of the encoded stream by the Windows Media Server, which simultaneously captured the stream and archived it for later use. Users across multiple sites could view the live [or later, the archived] feed within a Web page housed on the server. The Web page was more useful that a simple mms:// feed because ancillary data could be staged in the static elements of the page. There has yet to be found a way to facilitate two way communications during a typical "seminar". Success may lie in newer products such as the FLASH Media Server.

In the case of online or Web-enabled education courses, more student buy-in and subsequent success may be achieved with more "real-time" communications such as "video" course introductions and orientation sessions given by the instructor. Although not "live" they can be useful to personalize the instruction and serve students who benefit from "seeing and hearing" rather than just "reading". Adobe Captivate was used to make these FLASH objects that were staged on the LMS. Web-based live classroom sessions were also piloted within the LMS, which allows some native features - a white board, Web page display, shared applications, and chat. The chat can become hard to follow if many students were engaged, but a new product from Horizon Wimba was piloted in fall 2007 that added bi-directional, but only half duplex, video and/or audio to the LMS. There was some success with the both the native Blackboard and Wimba live classrooms, however, the usual attendee was the more successful student, since the synchronous "chat" or live classroom had to be linked to during the presence of the instructor. We are working with text messaging with SMS and/or a "twitter" type service to see if that is better accepted by the online student body.

2.3 Learning Assessments

Assessing the learning of students is a challenge in both face-to-face and distance/online learning situations. We've found that many assessment events that would usually take time in the classroom can now be delivered with the campus LMS on the students' own time. The major issue is being sure who is taking the online exam, since passwords and userid's can be shared. The solution has been two fold; one the test center approach, where a proctor supervises a computer lab where tests are taken with mediation of the LMS, and the second, a redesign of assessments so they have less credit and are used as more of a mastery solution. This latter approach reduces the credit giving for online assessments, but is less impacted by test taking by people not the enrolled user. The test center approach is very powerful and can support many courses at once with very little staff commitment.

2.4 MODIS Data Acquisition and Access

For environmental and Earth Science education there is no substitute for access to remotely sensed data. Almost any student is engaged by such views once they can figure out "where they live" and understand what it is around them. The major impediment to acquisition of such images in usually time and cost. Time is a problem in the sense of finding and procuring images as well as the sense of time since acquisition. The cost issue is tied to time; the older the data, the more likely it can be acquired for free. New[er] data is difficult to acquire. We have long desired real-time access to the direct broadcast stream of data from the U.S. National Aeronautics and Space Administration [NASA] Moderate Resolution Imaging Spectroradiometer [MODIS] instrument. However, the acquisition and operation of a receiving station is too expensive for a small University and although direct broadcast signals can be acquired, they are a challenge to convert to useful image data sets.

What we Did: We were fortunate to find a solution; we acquire near-real-time MODIS data from a source supplying the U.S. National Oceanic and Atmospheric Administration's Weather Service. To support weather forecasting, the Weather Service has access to MODIS data within two hours of its acquisition. This time frame is good enough for our educational application, so we browse their data holding once a day and download regional images. The NOAA MODIS site holds five days of global five-minute swath granules, the archive being refreshed on a first-in first-out basis. We have developed a process to browse their metadatabase, which holds basic quality and geographic coverage information for each granule; choose datasets within our geographic area of interest; and download those data.

This is all done with a simple PERL script and FTP. This has allowed us to acquire and disseminate MODIS data for the mid-Atlantic area of the U.S. within a very few hours of its acquisition. With manual changes in some of the script parameters we can acquire data from other regions of interest. At this time we only retain images from the mid-Atlantic region that have low cloud cover. We are working on integration of these data with our LMS and/or a Web-accessed geographic information system so that local users may download and/or visualize data that may be of interest. The use of the GIS approach has had some challenges since the set up and maintenance of the Internet services is complex [we're working with ESRI's ArcGIS Internet Mapping Service].

3. RESULTS & DISCUSSION

The results from this project have been well received by all those who have had access to the various features. By far the greatest beneficiaries of this work have been the students of the BIOL203 course, although others all across campus have also had access as their instructors acquire facility with the tools. In the last few years there has been a steady decline in the number of students who prefer the DVD of *Endless Voyage* rather than the streaming media product. This preference has changed drastically, due in large part to broader penetration of high

speed Internet in the students' homes and places of work.

The conversion and production of the media for streaming was tedious and time consuming as most of the steps require "real time", meaning 30 minutes processing time for each 30 minutes of media output [or more!], but once created, the files need not be re-processed. The full capabilities of the streaming server have yet to be tested, although in theory the number of simultaneous users can be estimated by dividing the total bandwidth available, say 1 Gb/second by the media bandwidth. So with a 250 Kb/second stream, a theoretical 4000 sessions could be supported. At present there are seldom more than 10 or 15 simultaneous users. Many problems have been found to lie with the user's browser security setting, business and organizational network settings and other issues with the provision of media files to users [like appropriate browser media plugins]. The media is going out on the Web; it just may be prevented from loading and playing due to network configuration beyond the control of the user and/or provider of the media stream. There have also been problems with the few non-PC Windows users who may not be able to successfully visualize Windows Media files. A change to another media, like FLASH is being considered. Testing will take place during summer 2008.

4. CONCLUSIONS

This project has brought many new Internet-based capabilities to the Bowie State campus, now utilized by its faculty, students and staff and those of other institutions. It has improved communications, educational and outreach capabilities. Besides making significant improvements to the delivery, effectiveness and utilization of a general education marine sciences course, their have been major upgrades to communications, the project has tested live Web classroom/office hours and provided for the live Web delivery of research seminars and other presentations within the NOAA CREST Project, as well as creating a Web archive of past presentations. A simple means has also been developed to review, select, acquire and stage regional MODIS data in near-real-time to the Web. The author has demonstrated the utility of, and stimulated the broader use of streaming media on campus and has worked with the Division of Information Technology to beta test a Windows Sever 2003 Media Services solution inside the campus firewall to supplement the NOAA CREST Live@BSU server. We have begun the conversion of all previous "television" courses to streaming media in order to supplant the recently-ceased broadcasts of this content on Maryland Public Television and our own campus station. We are planning to test this system for live broadcast of campus events to the Web to allow users access from on- and off-campus and to record and archive these events to a Web repository. Future work will evaluate the replacement of Windows Media Services, our streaming format, with other streaming servers and formats, such as FLASH, to bring better multi-platform performance.

Significant work remains to integrate the near-real-time staging of regional MODIS data with the campus LMS. The LMS is geared toward occasional updates to relatively static content, but Java scriptlets should be useful for this work. The LMS does have an integral syndication capability, and this will be used to "push" new MODIS thumbnails and/or full scenes to subscribers. The ultimate solution may lie outside of the LMS since its structure and operation are optimized to fulfill other strategic operations.

This project has shown that significant improvements can be made in the range of services provided on the Web with only a few simple, low cost solutions. There is little need for most organizations to contract for digital conversion, streaming media services, hosting or content, if medium duty server capacity is already available. There may even be capacity to host live Web broadcast of campus television and radio stations, giving them a much broader listening/viewing audience, than that of their traditional, and very local broadcast services. This could easily be done with simple encoding programs and would even allow program archiving. Encoding live broadcasts, with simultaneous push to a streaming server can be done by even the simplest computers with Webcams or more sophisticated cameras connected with FireWire IEEE 1394 interfaces. It has been our experience that no one should hesitate to try out live and/or archived streaming services for themselves and their campus community to improve educational outcomes, increase efficiency and promote better communications.

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APPENDIX

Useful Web Links

DVDecrypter:
http://fileforum.betanews.com/detail/DVD_Decrypter/1011845169/1

Windows Server 2003 Media Services:
http://www.microsoft.com/windows/windowsmedia/forpros/server/server.aspx

Windows Media Encoder:
http://www.microsoft.com/windows/windowsmedia/forpros/encoder/default.mspx

Adobe Premiere Pro 2.0:
http://www.adobe.com/products/premiere/

Adobe Captivate
http://www.adobe.com/products/captivate/

Adobe FLASH Media Streaming Server
http://www.adobe.com/products/flashmediastreaming/

RealNetworks Helix Streaming Server
http://www.realnetworks.com/index_rn.html

Example NOAA CREST Archive Live@BSU:
http://noaacrest.bowiestate.edu/crest/noaacrestdayuprm.html

An episode of *Endless Voyage*:
*mms://noaacrest.bowiestate.edu/BIOL203/EV01.wsx*INTELECOM - *Endless Voyage* provider
http://www.intelecom.org/course_info.asp?id=41

Respondus & Study Mate - LMS enhancement tools
http://www.respondus.com

Twitter *http://twitter.com*

ESRI ArcIMS
http://www.esri.com/software/arcgis/arcims/index.html