Development of a Web-Based Curriculum in Civil Engineering Technology

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ABSTRACT

This paper highlights the work at Bluefield State College (BSC) in developing a web-based baccalaureate degree program option (B.S.) in Civil Engineering Technology (CIET) that remains TAC of ABET accredited.   Capitalizing on the initial success of our web-delivered courses in the School of Engineering Technology and Computer Science (SETCS) through its Center for Applied Research and Technology (CART), this work describes the research process used to measure our capability to provide an online version of our program. Mid-career professionals interested in completing degree requirements without having to attend on-campus classes represent a new student target for our civil engineering technology program.

Quality assurance is paramount. The paper addresses the development of this new delivery method. The curriculum is designed to operate in an interactive web-based environment for submission of coursework, concept diagrams, drawings, reports, and assorted forms. Class discussions, conferencing, forums and real-time project reviews will utilize current "chat-room" technology and newly emerging conference software applications. Testing opportunities will be devised through models similarly employed by Sylvan Learning Centers and National Council of Architectural Registration Boards (NCARB) allowing online vignettes and projects.   The research will help determine the extent and volume that portfolio materials will be allowed to be used as submissions for program requirements.

The research will analyze the hardware needs required by the institution for customers. Cost analysis will relate to delivery of the program, individual courses, and impacts on faculty resources. Research will examine development of marketing strategies and propose market pricing for tuition and fees required by the program.

1.   INTRODUCTION

The CART Course Management System (CMS) was developed by the Center for Applied Research & Technology, Inc., to enhance the competitive position of Bluefield State College for applied research and technology opportunities in the current environment. Goals of CART are to promote the general economic development of the region; expedite and simplify the acquisition and utilization of research contracts; improve technology transfer; and link applied scientific research and technological advancements to economic development of the State of West Virginia. CART is a non-profit, non-stock corporation under the general corporation laws of the state organized exclusively for educational and scientific purposes. CART fosters and supports applied research at the Bluefield State College School for Engineering Technology & Computer

Science and provides evaluation, development, patenting, management and marketing for the inventions and diverse service capabilities of its students, faculty, and staff.

The associate of science degree in the Civil Engineering Technology (CIET) was initiated in 1962 and the Bachelor of Science degree was initiated in 1967. The associate and baccalaureate science degrees were initially accredited by TAC of ABET in 1972 and 1976 respectively. Students are provided the knowledge and skills immediately useful to contractors, consulting engineers, surveyors, architects, industrial firms, utilities, and certain government agencies. Employment opportunities open to graduates include structural design, construction materials analysis, surveying, and assisting civil engineers in the analysis, design, and construction of other facilities. One may view the CIET curriculum at www.bluefieldstate.edu/.

This led to the interest in developing a web-based curriculum that could reach prospective students outside our traditional service area. We have enjoyed success in delivering COSC 201 P.C. Software Applications (100% web delivered), and CIET 204 Reinforced Concrete Design (blended course) via our own CART CMS. We also have three other programs that are supplemented by the CART CMS. This expansion of web-based delivery presents obvious and not so obvious challenges particular to the delivery of a Civil Engineering Technology online curriculum. Critical analysis of the advantages and disadvantages of such program delivery is presented.

2.   COMPARISON OF CART CMS AND WEBCT

Data obtained from a comparison of CART CMS and WebCT suggests that CART CMS is more flexible, easier to customize, and more user friendly. We needed to develop our own CMS to take advantage of an open Architecture PEARL-based system that could be customized to our specific needs and requirements. CART CMS gives more flexibility of course formats such as by week, by topic, or a discussion-focused social format. WebCT uses a more "web like" environment of icon-based menus. WebCT does not allow one to structure the course homepage as easily as with CART CMS. WebCT may have a stronger testing environment with more controls and options than CART CMS; however, CART CMS test banks are easier to upload in more typical formats. Since CART CMS is an active and evolving work in progress, it is gaining on WebCT with more controls and options with regard to testing. CART CMS has an onsite administrator, whereas, Web-CT has a liaison with the actual primary support at some other site.

3.   COURSE DEVELOPMENT

        A. *Web Facilitated Course* Development

Over the past three semesters we have added web facilitation to the following classes with CART CMS; P.C. Software Applications (COSC 201), Statics and Strength of Materials (CIET 203), Hydraulics (CIET 212), Environmental Systems (CIET 301), and Construction Estimating (CIET 220). We plan to have all civil engineering technology courses facilitated by the web by

the fall of 2006. The students will have global "24-7" access to course materials, as well as, meeting face-to-face in the classroom.

B. *Blended/Hybrid Course* Development

Blended/Hybrid courses provides the student and instructor with "24-7" access to course materials and live lectures at least 50 % of the regularly scheduled class time.   Over the past two years, we have developed a Reinforced Concrete Design (CIET 204) course which meets in the classroom two hours per week and the remainder of the course material is web enabled on the CMS.

It is a requirement of this class that all assignments be uploaded to the CMS. All calculations are to be made in Excel and then pasted into a Word document that contains the rest of the assignment. At present, our CMS allows one document to be uploaded for each assignment. By the use of the "special paste" feature, we can review calculations in the Excel worksheet and see the formulas used without splitting the assignment submissions. Students must upload assignments by the due date displayed on the course site weekly schedule outline.

C. *Online Course* Development

An online course provides the student with "24-7" access to course materials and has no face-to-face meetings in class. Over the past two years we have developed a P. C. Software Applications (COSC 201) course in which the entire course is web delivered.

It is a requirement of this class that all assignments be uploaded to the web site. Since this class utilizes Microsoft Office 2003, assignments are to be uploaded files in Word, Excel, Access, or PowerPoint. We also require each student to upload a portfolio of all coursework performed during the semester excluding tests and quizzes which are logged separately. The CART CMS allows one document to be uploaded for the portfolio and is limited at the present time to 2 MB. Students insert files from each of the other softwares into a word document which becomes their semester portfolio. The CART CMS allows the instructor to input databases for tests; instructors may create the file in word or import the test in specific formats from notepad files. Assuming the instructor has generated a large enough database, we can have the CMS generate random test questions for each student.

Course materials students have "24-7" access to for the *web facilitated, hybrid,* and *online courses* are: (http://cartlink.org)

- Course Syllabus
- Course Calendar
- Course Requirements
- Course Assignments
- Lecture Notes
- Example Problems
- On line Tests (Random Generated)

- News and Announcements (Bulletin Board)
- Student Question and Answer Forum
- Access to other students in class
- Access to Professor and assistants by email addresses, chat rooms, or virtual office hours.
- Direct links to book sites
- Direct links to professional and other course related sites
- Access to grades
- Assignment uploads

4.   ADVANTAGES AND DISADVANTAGES OF WEB FACILITATED, BLENDED/HYBRID, AND WEB DELIVERED COURSES

A. Advantages for Students:
1. Students gain continuous access "24 – 7" to the course. Our students have found this invaluable in most cases since approximately 80% of our students work part time or full time.
2. CART CMS opens communications with students and faculty in a variety of formats.
3. Our CMS helps students organize their course work; the student sees the whole course one week at a time.
4. Scheduling "surprises" are eliminated ("Our test is today?") in the course; the entire semester schedule is displayed before the student on a single scrolling page.
5. Use of technology encourages student achievement in technology programs.
6. Students receive immediate feedback on their test scores.
7. Student access their own updated grade book displaying feedback on individual questions and assignments scored with a running total throughout the semester.
8. Students are reminded of deadlines on a calendar marked up with important dates.
9. CART CMS allows for some flexibility in the students set schedule to better enable work and internship experiences.
10. Students must meet deadlines in an increasingly self-motivated environment.
11. Students must self motivate in general and avoid procrastination without traditional verbal reminders of assignment due dates.

B. Disadvantages for Students:
1. Student must still meet in class for the regular scheduled class times for web facilitated courses.
2. Students uploading assignments to CART CMS may require more time than writing it out by hand.
3. Student must have access to compatible hardware, software, and high speed web connection.
4. Students may need to access computer laboratories at school, libraries or other places with public access to the web, particularly during tests.
5. No face to face interactions with other students in web delivered courses.

6. No face to face interactions with Instructor with online courses.
7. No in class explanations or examples with online courses.
8. Instructor's expectations may be greater for online courses that those in the normal classroom settings.

C. Advantages for Faculty:
1. Faculty schedules become more flexible in accessing and maintaining the course.
2. Faculty realizes increases in quality of communications with students.
3. Faculty organizes course materials and adheres to the course schedule.
4. Faculty experience self satisfaction related to the customizable web enabled assessment features and pride in tangible authorship of quality material.
5. CMS enables flexible virtual office hours and private communication.
6. Use of technology encourages faculty to try new and innovative methods for delivery of fresh course materials.
7. CMS grade book facilitates a better managed class where front end quality is emphasized.
8. Faculties maintain a single source with backup of course materials and assessment documentation in an increasingly paperless environment.
9. CMS keeps log of all activities on web site of students and faculty.
10. The ever-changing nature of the CMS helps keep faculty updated on their computer and technology skills.
11. CMS could provide the College with a "time sheet" or create other privacy issues for faculty and the institution.
12. CART CMS is an open architecture PEARL-based system that can be customized to perform consistent to our own requirements

D. Disadvantages for Faculty:

1. Web courses are not a time saver for the faculty, they actually require more time. It is more of a trade off between intensive front end preparations for more flexible hours in course administration and delivery.
2. Some faculty feel compelled to excessively manage, draw conclusions from poor data presented powerfully or have unrealistic expectations about 24-7 access.
3. New courses, in particular, require a large work investment up front before the class can go online.
4. CMS could provide the College with a "time sheet" or create other privacy issues for faculty and the institution.
5. Faculty constantly battle to keep up with technology, course material, and with the students without live meetings.
6. Any CMS requires an especially dedicated and self-motivated faculty to create and maintain courses that are of equal quality or better than traditional instruction.
7. Our College does not offer incentives for faculty to do the extra work involved in developing a web-based course.
8. Trying to conduct laboratory experiments is very challenging and at present is almost impossible.

9. Need to develop more communications up front with students regarding requirements and retention.

5.   MAINTAINING QUALITY

Pairing the lessons learned from past and current online delivery schemes with our overall experiences with the program, we want to address our own TAC of ABET accreditation requirements without compromise. We plan to enhance our delivery of the program without simply creating a web-based novelty. We have used online student course evaluations and have found the results to be similar to in-class.

We offered an in-class section and an online course in P. C. Software Applications in the same semester and have found the following results:

Grades	Web Delivered Course	In Class Course
Outside Assignment Average	77	73
Test Average	67	68
Portfolio Average	94	75
Final Class Average	80	75

The results imply that the students taking the in-class course do not enter with the same level or have the same comfort level with computer skills and web technologies as students deciding to take a web-delivered course. This is reflected in the higher scores on assignments and the portfolio. The test scores have been relatively even. The web course randomly generates a new test for each student from the database that the instructor created. The in-class test is one of the randomly generated tests given during a traditional class meeting. The web-delivered course generates secure random tests for each student that makes it nearly impossible to compare answers in real time. There is also a time limit set (timer in corner of screen). If the student does not submit test within the time frame the CMS will record a zero for test. The CMS does not record answers until a student submits the test.
The assignments are realistic and maintain equivalent rigor regardless of the delivery system. For the students to complete the assignments, they must put forth time and effort. We are not concerned with ease; we are concerned with a quality learning experience. Successful students are open to adapting to the format, inquisitive enough to open all the links and read, and interested in research compatibility with their systems. They are rewarded in turn with full experience in modern communications media and engagement with their own schedules. We vary the assignment complexity as well as update and change assignments each semester. Our goal is to maintain the CMS in a non-compromising environment.

The requirements for successful delivery of our program will remain consistent with the program outcomes in our Civil Engineering Technology program.

a. an appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines,

b. an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology,

c. an ability to conduct, analyze and interpret experiments and apply experimental results to improve processes,

d. an ability to apply creativity in the design of systems, components or processes appropriate to program objectives,

e. an ability to function effectively on teams,

f. an ability to identify, analyze and solve technical problems,

g. an ability to communicate effectively,

h. recognition of the need for, and an ability to engage in lifelong learning,

i. an ability to understand professional, ethical and social responsibilities,

j. a respect for diversity and a knowledge of contemporary professional, societal and global issues, and

k. commitment to quality, timeliness, and continuous improvement.

Assessment of these outcomes is on going, and continuous improvement is expected. During the last TAC of ABET visit, we presented evidence that our online courses were equal to or better than in class.

6.   DELIVERY SYSTEMS

A wide variety of online programs are being offered across the nation. The courses being provided by these programs provide students with many online features such as: registration, syllabi, course materials, schedules, class notes, online testing, document submissions, and chat rooms for discussions, forums, and grade recording. Our program requires additional elements to be successfully implemented. The program will require a means of including sketches/drawings with the spreadsheets, presentations, projects, and graphic/text examinations. We have numerous courses that have laboratory components for conducting experiments, soils and materials testing, surveying, etc. Assignments will be submitted, marked up for modifications and corrections, and then posted for return. Presentations will be made to an online audience of faculty, guest reviewers, and other students in the class. At times, we will record live presentations by the instructor on laboratory procedures for review at later dates on the web. This method will also be used to record problem solving sessions in lieu of live "chalk talk" sessions in the classroom. We will also need to organize students into work groups that allow them to collaborate on projects as well as work independently of other groups. Our CMS currently supports online student grouping functions.

Graphic Material

Drawings will need to be created in specific formats using standard nomenclature; titles, scales, uniform sets of symbols, and text appearance criteria. Projects submitted for these scheduled reviews will be marked-up for modifications, deletions, and corrections utilizing current Tablet PC Windows features or equivalent. Drawing files are uploaded through the CART CMS as

.DXF, .DWG, .JPG format files or as embedded drawings in Excel worksheet and word files. Some sketches may even be created in word or other cad type software and copied into Excel. In the Reinforced Concrete Design course, students draw shear and moment diagrams in AutoCAD and use the copy and special paste features to embed the drawing in Excel worksheets. The use of the special paste feature allows the instructor to double click on the drawing to mark up or edit it. To post for the student to review you must save, close file, re-embed it into the spreadsheet, save and close the Excel worksheet, and then upload file back to site. Assignments, projects and drawings will be archived and maintained as portfolio evidence on the CART CMS server. Students may also access these files and insert them into a word document thereby creating their own Portfolio for the course. The use of graphics is workable to a point but more research and development is needed for integrating shareware, so as not to cause such a financial burden for the students by having to purchase so much software.

Presentations

The program will require students to compose presentations in the courses involving environmental issues, analysis and design, site planning, surveying, materials testing, and transportation. Presentations will be delivered to a variety of reviewers: faculty members, guests from civil engineering and construction, and other students in the course. Presentations may be prepared using PowerPoint or other presentation software and presented in real time. The challenges here may be the audience aspect as well as live viewing of the speaker and the question and answer portion of the presentation. How can we enable more reliable high speed two-way broadcasts of these materials? How can our CART CMS evolve to allow web-casts and viewing for everyone involved? Formats such as streaming video and web-cam broadcasts are possible. Greater access to broadband is emerging that provides better opportunities for students accessing course presentations.

Workgroups

Course work in the CIET Online program will involve projects assigned to student groups. Laboratory courses in the program require students to work effectively in teams. Developing and maintaining teams in online format course will pose the most problematic set of challenges in the program. Program courses will also use existing CART CMS "chat rooms", forum technology, and virtual office hours for collaboration between group members and faculty. Newly emerging conferencing software such as Visio will provide software features that establish better communications, and use of other electronic "gadgets" that will help with team work issues in the program. Software features will establish communications parameters between members of individual groups, while providing security via password from viewing by other nonmember students.

Online graphic/text testing

The CIET Online program poses a situation that will require an innovative solution to the online testing challenge. Some courses in the program will require a series of real-time graphic examinations combined with text and the need for third party professional software for the

solution. We plan on setting the text testing up so it would follow closely the Fundamentals of Engineering Test format. Each course will have a database of questions, problems, and vignette's which take a considerable amount of time to develop. The exam solutions will be stored on the site for retrieval by the instructor. Grades for text exams will be posted immediately while graphic exams will be graded by the Professor and then posted.

7.   SYSTEM RESOURCE REQUIREMENTS

 In order to successfully run the CART CMS the student will need Windows® 2000, XP or Tablet PC XP and for best performance we recommend:

- Pentium III processor or greater equivalent
- Windows 2000® or XP
- Microsoft Office 2000®
- Microsoft Word®
- PowerPoint®
- Microsoft Excel® (for selected courses)
- Microsoft Access® (for selected courses)
- Microsoft Project 98 ® or 2000® (for selected courses)
- Microsoft Visio 5.0 ® or later (for selected courses)
- A current anti-virus application
- 512 MB RAM or greater
- 20 GB hard drive or larger
- DSL or cable modem
- 1024x768 or greater monitor and video card
- Sound card with speakers
- CD ROM
- Inkjet or laser printer
- E-mail address
- Internet service provider (ISP) account
- Microsoft Internet Explorer Version 6.0 or later

8.   TUITION AND FEE STRUCTURE

The anticipated fee structure for online courses will be $117 per credit hour. These costs will defray the cost of instruction; instructor salaries, and benefits, courseware development, server security and system maintenance. These cost figures were established through a combination of informal market research of other online programs across the country and are consistent with current tuition and fees. The table below summarizes these costs and fees:

Type of Fee	Amount	Payment Due
Application Fee	$100	At time of application.
Undergraduate	$117 per credit hour	At time of course registration
CART CMS Fee	$35 per credit hour	At time of course registration
Electronic Access Fee	$35	At time of course registration

9.   CONCLUSION

We have learned through our experiences with other CMS's that controlling the organization of the site and ease of updating material is of utmost importance. Instructors want to control and update the site without becoming HTML programmers. The website at www.cartlink.org is continually evolving to respond to the increasing requirements. The basic philosophy is that no one can simply put an instructor's course on the web for them, then stand back and watch it perform. Conversely, instructors will be more than reluctant to use a CMS that requires that person to become a programmer. CART CMS was designed to require a limited set of instructor proficiencies used in the current office setting.

Instructors upload course materials that were created in familiar software rather than learning in a one-time, single point-of-use environment that is subsequently replaced by unique software. Working within the standard Office suites encourages faculty to continue developing course materials consistent with existing resources. If we are able to complete the development of a graphic testing module, and enhancements to our drawing file exchange, then we should be able to both maintain an acceptable comfort level, while creating the "red line" markup capabilities vital to graphic communication in any civil engineering technology program. Tablet PC operating systems could provide a universal grading by markup capability without the need for additional software. The instructor would mark the student posted assignment on screen, then repost for student review of grades. The graphic testing module will essentially operate as a simplified CAD template populated by symbols limited to the appropriate subject.

In a general sense, recent results of student satisfaction surveys have highlighted both the strengths and weaknesses of their online experiences. We will have to overcome several conditions to better provide an online curriculum.

- Students sometimes enroll in online courses as a "catch all" solution because of scheduling conflicts with other courses, work, etc. They may lack web experience, computer skills, or even the self-motivation required for success. We do not want students to take these courses because nothing else would fit.

- The quality of previous online experiences may lead the student to believe the myth that these courses do not require as much of their time or lack rigor. We are developing a "Student Responsiveness Policy" to replace our "Attendance Policy" in response to this wide variance in quality of experience. We want expectations

of the students and the faculty to match. Based on the courses we have developed so for, we are changing this myth.

- The development of a well-designed and tested web course orientation, mini-training program, and a *CART CMS 2.0 Student Guide* for first time online student could become a key factor in their success and satisfaction with the program.

- The need for a closer relationship with the general registration for the school and the registration on the web site for the individual courses. At the present time each registration is done independently.

- The web-based curriculum requires a full-time web technician to provide trouble shooting assistance to the students, faculty, and the CART CMS web master. It also requires release time to faculty members for design, development and testing. We want the program to continue running smoothly while experiencing growth and development.

- We envision our web-based program serving 100 Civil Engineering Technology students in a national and international setting within the near future. A targeted web-based marketing plan must be devised to attract students with the proper background for success. We should partner with a variety of other institutions and organizations where common student serving interests exists.

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