Teaching Software Engineering and
Computer Science Online Using Recent Instructional Technology

PATRICK BOBBIE

PATRICK BOBBIE is currently professor in the Department of Computer Science and Software Engineering at Southern Polytechnic State University (SPSU) in Marietta, Georgia. He has a Ph.D. in Computer Science from the University of Louisiana, Lafayette. Email him at: pbobbie@spsu.edu.

SHERYL DUGGINS

SHERYL DUGGINS is currently professor and graduate coordinator for the MSSWE program in the Department of Computer Science and Software Engineering at Southern Polytechnic State University (SPSU) in Marietta, Georgia. She has a Ph.D. in Computer Science from the University of Florida and an M.S. degree in computer science from the University of Missouri, Columbia. Email her at: sduggins@spsu.edu.

VENU DASIGI

VENU DASIGI is currently professor and department chair of Computer Science and Software Engineering at Southern Polytechnic State University (SPSU) in Marietta, Georgia. He has Ph.D. and M.S. degrees in computer science from the University of Maryland, College Park. He has taught for about 25 years in higher education, which includes developing and teaching online courses in data structures and mathematical structures for computer science at SPSU. Dasigi is a Commissioner with the Computing Accreditation Commission of ABET, Inc.

Teaching Software Engineering and Computer Science Online Using Recent Instructional Technology

Abstract – Higher education is fast becoming a very competitive market with the plethora of universities offering online degrees increasing across the country. Our university has been offering distance education in various forms since the 90s. But the courses we could offer using distance technology of the 90s were limited due to the nature of our content – computer science and software engineering courses typically have technology requirements that could not be supported at that time. Now with high-speed internet connections and new technologies, we are no longer restricted by our content. Besides the availability of new technologies, there may also be pedagogical reasons to consider adding online components into student learning, according to some studies.

This paper will address learning content management systems and classroom tools used to facilitate online courses. Specifically, we will discuss the various tools and techniques we have used and incorporated in the development and delivery/teaching of courses in the School of Computing and Software Engineering. For development SmoothDraw™, Camtasia™, Tablet PCs, and Blackboard/Vista™, will be examined. We'll explore the use of Echo360™, wall-mounted cameras, Wimba, SmartBoard™ and tablet PCs for delivery. For content management we'll explore Blackboard's Vista™ and Sakai-Globule.

Keywords: Distance learning, Online learning, e-Learning, Learning Content Management Systems, and Course Management Systems.

Introduction

Higher education is fast becoming a very competitive market with the plethora of universities offering online degrees increasing across the country and around the world. Studies indicated that as early as 2001, at least 3 million US students were enrolled in online education [15], and there were 90 million students worldwide studying online at 986 institutions in 107 countries [5]. Today, the e-learning market has a growth rate of 35.6%, which makes online education a very competitive business [20]. In 2001, venture capitalists invested one billion dollars in education companies and "entrepreneurs are swarming to the marketplace" [11]. Sun et. al [18] have even suggested that e-learning is emerging as the new paradigm of modern education.

While some of the popularity of online learning is driven by the demand for increased convenience and access for students, there are important studies pointing to the enhanced pedagogical value of online education. A recent report from the U.S. Department of Education suggests that learning outcomes can be better achieved in certain groups of older learners in the online mode than the traditional face-to-face (F2F) mode of learning [14]. The results are even better for those taking the course in the hybrid mode. However, the study cautions against attributing the improvement to the online medium per se. One way to look at the results is that the conventional F2F mode is missing something that the online mode provides, e.g., extra time for independent reflection, which is perhaps particularly effective for older learners. The study also points out that the results may be more relevant to higher education than to the K-12

context.

The emergence of the Internet and advances made in information and communication technology as well as the technological advances made in multimedia, personal computers and networking has driven the development of distance learning in the *information age* [19, 12]. The need for "anytime, anywhere" learning has led to the development of e-learning, otherwise known as web-based or online learning, which uses "telecommunication technology to deliver information for education and training…The great advantages of e-Learning include liberating interactions between learners and instructors, or learners and learners, from limitation of time and space through the asynchronous and synchronous learning network model" [12, pps.1183-1184]. Maddux et.al. [13] suggested that higher education is on the cusp of a revolution due to several recent changes in technology including:

1 "Recent rapid growth of broadband Internet connections in private homes…
2 Recent widespread availability of free or inexpensive programs that make use of voice over Internet protocol and video over Internet protocol…
3 Transition of the World Wide Web from a space where users search for and read information to an environment for collaboration…
4 Much wider and currently rapidly increasing availability of high quality educational websites."

This paper will give an overview of the state of distance education today, and will take a look at what's being used at our university. We will address *learning content management systems* and classroom tools used to facilitate online courses. For content management we'll explore *Blackboard's Vista™* and *Sakai-Globule*. For development *SmoothDraw™*, *Camtasia™*, tablet PCs, and *Blackboard/Vista™*, will be examined. We'll explore the use of Echo360™, wall-mounted cameras, Wimba™, SmartBoard™ and tablet PCs for delivery.

Distance Education at [Our University]

[Our University] has been offering distance education in various forms since the mid-1990s. The technology we used at that time consisted of telecourses and videotapes. To facilitate the recording and synchronous delivery at that time required extensive technological support. A special classroom was built on campus that was equipped with cameras, microphones suspended from the ceiling, television screens capturing the students at the remote locations, and a special tech room off to the side of the classroom filled with recording and transmitting devices and manned with a technician running the equipment. The remote sites were equipped similarly, so that in effect, all locations were both sending and receiving audio and video feeds. But there were limits to what we could do at that time. Specifically, the courses we could offer using 1990s technology were limited due to the nature of our content – computer science and software engineering courses typically have technology requirements that could not be supported at that time. Our face-to-face students were able to access the required software via our Computing and Software Engineering (CSE) labs, but offering these tools to our distance students was impossible as we were limited by the 1990s technology.

Learning Content Management Systems

One of the biggest changes in distance education was the development of Course Management Systems (CMS). In 1999, the University System of Georgia (USG) adopted WebCT as the standard USG online course delivery format [8]. WebCT is a Course Management System that provides a number of features including calendars, threaded discussions, assignment tools, tools for creating and viewing grades, email services within the tool, file management tools for uploading and downloading files, whiteboards, online chat, and a number of other tools. Together these tools provide a complete learning environment for distance classes. The USG replaced WebCT with Blackboard/Vista, which is the CMS the USG is currently using. However, as technology advances at a rapid pace, we will be moving to Desire2Learn [6] within the next two years. "To meet the needs of the students and faculty of the University System of Georgia in the 21st century, the USG LMS transition task force strongly recommends adoption of the Desire2Learn platform as the next generation USG Learning Management System. This platform outranked all of the competitors in all areas of consideration other than the ease of transition. The lead in that category was Blackboard Learn 9, which is not a surprise given that the system will be moving from a Blackboard product currently in use. However, Desire2Learn was a fairly close second place contender in this area [19]."

In the early use of these CMS, the virtual classroom was eerily similar to a traditional face-to-face classroom in which the professor "lectured" in the front of the classroom to the passive students who sat quietly at their desks. Online classes at this time consisted of "lectures" that the students *read* that were posted in the CMS, as opposed to traditional F2F classrooms in which the students *hear* the lecture as it's happening live, at a time when all the students and the professor were gathered physically in the same location. In a F2F classroom discussions occurred in that same physical classroom, and all students could ask questions and hear all responses. In the CMS classroom discussions, the students participated asynchronously, whenever and wherever they were when they logged into the CMS. The other students could "hear" (via reading) their classmates' discussion points and contribute to the threaded discussion or ask a question or make a comment by starting a new thread in the discussion topic. It was a nice simulation of or alternative to a traditional classroom. Unfortunately, not all students succeed in this type of learning environment, and a number of online students stop their online learning after their initial experience [18]. Research has shown that online students who take courses of this type, in which the communication is delayed, asynchronous, and without a personal, human feeling to them feel isolated and dissatisfied with the learning environment [1, 4].

The two most frequently used Course Management Systems in 2006, WebCT and Blackboard, which were used by 48.8% and 41.9% respectively of Blakelock's [2] 37 survey respondents, have since merged when Blackboard purchased WebCT in 2006. As of today, the term Course Management Systems is still being used, but more frequently these types of systems are now called either Learning Management Systems (LMS) or Learning Content Management Systems (LCMS). Today, instead of just two products dominating the market, there are now many competing products available, including open source, however Blackboard is still the leading educational course management system [11].

In addition to using Vista™ at [Our University], some professors are also experimenting with Sakai-Globule, which is open-source, and is gaining popularity and is being used by institutions like Georgia Institute of Technology. Sakai, free software, provides capabilities

for storing and managing course data, student profile and assessment data like exams, projects, etc., and revising of such data. Globule is integrative with Sakai by offering a server-based environment for developing content for eventual 'pushing' to Sakai servers wherever they may be sited in a network of campuses or locations.

Sakai is a collaborative learning tool which has been deployed by hundreds of institutions and thousands of instructors, and millions of students have benefitted from it. One of the strengths of Sakai is the ability to incorporate and deliver real-world simulations in lectures to stimulate student interest and learning. The desire to develop a rich and strong course management system (CMS) for content sharing and engaging students prompted IBM and Sakai Foundation to sponsor the *Teaching with Sakai Innovation Award Program (TSAIP).* TSIAP is aimed at identifying and recognizing users of Sakai in inventive and exemplary ways [17].

While Sakai provides a rich environment for inventive learning and sharing, ***Globule***™ is a server-based tool for developing and replicating content materials [10]. Thus, web-based documents can be developed offline using Globule to suit the pedagogical approaches of instructors, while allowing the design and development of lecture materials using different but integrative metaphors and multimedia content such as graphics, simulations, animations, text, power-point slides, video, and audio.

Development Tools

SmoothDraw™, Camtasia™, Tablet PCs, and Blackboard/Vista™ have been used for development. SmoothDraw is a graphics drawing tool, like the Paint™ component of Microsoft Office suite. SmoothDraw supports an array of digital-pens of different font sizes and types, which can be selected through the stylus of any Tablet PC for drawing, sketching, writing, or highlighting information or facts during course presentations. Further, SmoothDraw can be integrated with Camtasia, a screen capturing tool, which is rich with features for screen and video recording, editing, producing, publishing and saving of contents into a variety of formats including WMV (Windows Media Video), AVI (Audio-Video Interleave), M4V (for Podcasting, iPhones, and iTunes), MP3 for audio only or MP4 for audio-video, GIF for animation, and MOV for Quicktime™ movies. The saved lecture can be reduced in size for portability and fitness in small handheld devices or played back from dedicated servers using content management tools. Vista™ also supports an integrated set of tools for preparing, editing, importing, and organizing content data, files, images, and presentation files using its 'linking-based' feature for eventual delivery in Wimba™.

SmoothDraw™ is an environment like Microsoft Paint™ IDE for natural painting and digital free-hand drawing. As a software tool it can be used to produce high quality sketches, writing, diagramming/drawing, and developing illustrative content. SmoothDraw works with tablets and Table PC hardware so when used with audio-video interfaces such as WebCam and microphones/headsets, the user can develop rich, multimedia content for later (or real-time) processing and integration into CMS platforms. SmoothDraw supports such brushes as pens, pencils, and dry media; retouch tools; layers; and image adjustment. The array of digital-pens of different colors, font sizes and types can be selected through

the stylus of any tablet or Tablet PC for drawing, sketching, writing, or highlighting significant sections of contents during development [18].

Camtasia™ is multimedia software that provides capabilities to record on-screen movements of such metaphors as mouse and displayed multimedia content that appears on the screen. Camtasia allows the recording of a demarcated area of the screen which an instructor is interested in or where on-screen movements are confined to. The recorded content can then be further developed into videos using the rich set of tools for audio level selection; pause-restart features for recording; editing tools for clipping undesirable tracks of the recording and insertion of pre-recorded components, for example, pre-recorded introductory remarks, concluding summaries of lectures/presentations, or audio-clips used as jingles; resizing of captured content; customizable production settings of contents into WMV (Windows Media Video) and other formats like Flash, .avi, .mov, .m4v (for iPod, iPhone, iTunes videos), .mp3, and .gif (for animation). After the contents have been run through the production feature of Camtasia, the saved videos can be reduced in size for portability and fitness in small handheld devices or played back from dedicated servers using content management tools. This capability not only enhances learning, but also offers students distance learning options in anytime-anywhere modes, including wireless with mobility [3].

Tools for Delivery

Echo360™, wall-mounted cameras, Wimba, and SmartBoard™ have all been used for delivery at [Our University]. Tablets can replace SmartBoard™ to support delivery from private settings and have been part of the plan of universities such as ours to respond to pandemic situations. Echo360 is a server-based system which works with mounted cameras to capture live presentations. The immersion of SmartBoard illustrations and amplification of presentations offers students rich, video content for asynchronous playback and replay of the teacher's real-time discussions. Echo360 also can be deployed concurrently and non-obstructively while using Wimba, which is designed for delivery of power-point slides and synchronous interactions with online students. The final product of Echo360 is an editable video-file which is placed on a server for student accessibility. Certain tools on Tablets, e.g., MS Word, support freehand marking of assignments, which can be returned to students. These technologies have come a long way; students no longer need to bring individual compact tape recorders into the classroom and request the professor's permission to record her/his lecture!

The Echo360 System was developed by the Echo360 System group in partnership with the University of Western Australia. The system provides an opportunity for students to have access to classroom learning in an on-demand basis and frees students from traditional, synchronous barriers to learning. The on-demand option helps colleges and universities engage students anywhere, anytime and on student preferences that permit the combination of full-time or part-time work and full-time access to education.

Acquiring and installing Echo360 system could be expensive for small institutions in that it requires the purchase of hardware platform that includes a capture station with cameras

and microphones to record the video component. Using the Echo360 system also requires a minimum 30-minute wait period after the presentations for transcoding after upload to the Echo360 media server. The captured content is produced as a H.264 video, which is then transcoded to Rich Media, Flash, and vodcast formats on the server [8].

Besides the factors indicated in the U.S. Department of Education report mentioned before [15], the necessary use of a variety of technologies outlines above could also be a possible factor behind the effectiveness of the online mode of learning. The added convenience of remote and synchronous classes, avoidance of a commute, relatively self-paced learning, etc. can all provide incentives to a motivated and mature student.

Conclusions

This paper explored the technological advances that have changed the nature of distance learning. It gave a brief history of distance learning and examined the recent developments such as the rapid growth of broadband Internet in homes that have allowed for the increase in online education. The history of distance learning at [Our University] over the past decade was reviewed and specific tools and techniques utilized in distance education today were elucidated. We discussed content management systems, development tools, and delivery tools used to facilitate online courses.

We plan to continue our research by exploring how the strengths of these various technologies and other factors come together in impacting the effectiveness and quality of e-learning.

References

[1] Boulos, Maged, Taylor, Andrea D., and Breton, Alice (2005). A Synchronous Communication Experiment within an Online Distance Learning Program: A Case Study. Telemedicine and e-Health. October 1, 2005, 11(5): 583-593.
[2] Blakelock, Jane, Smith, Tracy (2006) Distance learning: From multiple snapshots, a composite portrait; Computers and Composition, Volume 23, Issue 1, 2006, Pages 139-16.
[3] Camtasia http://www.techsmith.com/camtasia/features.asp
[4] Dasigi, Venu, and Reichgelt, Han (2009). Issues with Online STEM Education – Assessment and Accreditation, American Society for Engineering Education (ASEE) Southeast Section Annual Conference, April 5-7, 2009.
[5] Davies, Larry, Hassan, W. Shukry (2001). On mediation in virtual learning environments; The Internet and Higher Education, Volume 4, Issues 3-4, 2001, Pages 255-269.
[6] Debeb, G.E. (2001). "Distance education in African universities: rationale, status, and prospect." *Newsletter of the International Institute for Capacity Building in Africa*, 3(3), pps. 14-16. http://www.unesco-iicbaorg/Resources/vol%203%20no%203%20english.pdf.
[7] D2L http://www.desire2learn.com/
[8] Echo360 http://finance.yahoo.com/news/Echo360-Lowers-Total-Cost-of-iw-1105481.html?x=0
[9] Funk, M. Leigh (1999). "The State of Distance Learning Technologies Used Within the Post-Secondary Institutions of the University System of Georgia." http://edtech.kennesaw.edu/leigh/comps/pc501paper.doc
[10] Globule -- The Globule User Guide

[11] Hart, Jane (2011) "Course & Learning Management Systems", Centre for Learning and Performance Technologies; http://c4lpt.co.uk/directory-of-learning-performance-tools/instructional-tools-course-learning-management-systems/
[12] Hedberg, Sara Reese (2002). "Web-based Education: A New Generation of Distance Learning is Emerging" IEEE Distributed Systems Online, Volume 2, Number 2. http://www.computer.org/portal/site/dsonline/menuitem.9ed3d9924aeb0dcd82ccc6716bbe36ec/index.jsp?&pName=dso_level1&path=dsonline/past_issues/0102/features&file=dis0102_print.xml&xsl=article.xsl&
[13] Jiang,Guorui, Lan, Junqiang, Zhuang, Xinhua (2001). "Distance learning technologies and an interactive multimedia educational system". *Proceedings IEEE International Conference on Advanced Learning Technologies*, Volume , Issue , 2001 Page(s):405 – 408. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=00943958
[14] Maddux, Cleborne, Sprague, Debra, Ferdig, Richard and Albion, Peter (2007) *Editorial: online education: issues and research questions.* Journal of Technology and Teacher Education, 15 (2). pp. 157-166. ISSN 1059-7069. Official URL: http://www.editlib.org/index.cfm?fuseaction=Reader.ViewAbstract&paper_id=24317
[15] Means, Barbara, Toyama, Yukie, Murphy, Robert, Bakia, Marianne, and Jones, Karla (2010). Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies, U.S. Department of Education Office of Planning, Evaluation and Policy Development, Policy and Program Studies Service, http://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf.
[16] Primary Research Group (2002). *The survey of distance and cyberlearning programs in higher education, 2002-2003 edition.* New York.
[17]Sakai-TSIAP http://campustechnology.com/Articles/2009/10/14/Innovating-Teaching-and-Learning-with-Sakai.aspx?p=1
[18] SmoothDraw http://www.smoothdraw.com/
[19] Sun, Pei-Chen, Tsai, Ray, Finger, Glenn, Chen, Yueh-Yang, and Yeh, Dowming (2008). What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education*, 50 (2008), 1183-1202.
[20] USG_LMS_Task_Force, 2011, http://www.usg.edu/learning_management_system/documents/USG_LMS_Task_Force_Final_Report.pdf
[21] Wu, J.P., Tsai, R.J., Chen, C.C, and Wu., Y.C. (2006). "An integrative model to predict the continuance use of electronic learning systems: hints for teaching." *International Journal on E-Learning*, 5(2), pps. 287-302.