AC 2010-1922: SUSTAINING APPROPRIATE TECHNOLOGY ENHANCED
LEARNING IN STEM DISCIPLINES

Steven Cramer, University of Wisconsin, Madison
    Associate Dean of Academic Affairs and Professor, Department of Civil and Environmental
    Engineering, College of Engineering

Robert Jeanne, University of Wisconsin, Madison
    Professor Emertus, Department of Entomology, College of Agricultural and Life Sciences

Moira Lafayette, University of Wisconsin, Madison
    Director of Assessment Academic Affairs UW-Madison College of Engineering

Michael J. Litkow, University of Wisconsin - Madison

Amber R. Smith, University of Wisconsin, Madison
    Department of Horticulture, College of Agricultural and Life Sciences

Lillian Tong, University of Wisconsin, Madison
    Faculty Associate, Institute for Cross-College Biology Education

© American Society for Engineering Education, 2010
Sustaining Appropriate Technology Enhanced Learning in STEM Disciplines

Abstract

The focus of this paper is on our collective experience in a Technology Enhanced Learning (TEL) project with the shared goals of promoting faculty development and encouraging the use of TEL solutions in STEM disciplines at the University of Wisconsin-Madison. Specifically, we will discuss the implementation strategies and results from a collaborative TEL project in light of the key instructional motivators and entry points for faculty within our organizational context and culture.

The initial TEL project in the College of Engineering (CoE) funded the development of a math editor tool; while the initial TEL Institute for Cross-College Biology Education (ICBE) project developed a tool to facilitate giving feedback to students. Both tools were created within the open source course management system (CMS), Moodle. Using an open-source CMS provided opportunities to move beyond the fundamental requirements of a CMS, and create a place for faculty and students to connect, interact and engage using a variety of teaching and learning techniques.

In this paper we describe the implementation and evaluation approaches currently underway by the CoE, College of Agricultural and Life Sciences (CALS), and the ICBE components of a collaborative 2009-2010 TEL project. Briefly, the ICBE component was to build upon the Feedback Manager module developed under the previous ICBE TEL grant with the desired outcomes of further adoption and development of the tool, continued faculty input, and assessment of the impact of the tool. The TEL CoE/CALS component focused on scaling up the use of Moodle known as Engineering Courses on the Web version 2 (eCOW2) within the CoE and CALS at an enterprise level with a surge of faculty support and technical assistance to further adopt the available tools in Moodle and integrate effective instructional design and delivery principles to positively affect student learning. Discussion of the two implementation approaches will provide a comparison of the similarities and differences, in approach, context for use, challenges and opportunities in leading to faculty adoption and development of tools and pedagogical practices.

Background and Introduction

Technology enhanced learning tools often steal attention from the main goals of course development based upon evidence-based instructional design and pedagogical practices that contribute to student learning. Herein we describe a Technology Enhanced Learning (TEL) project with the goal of providing a technology teaching platform that faculty can use to develop new approaches to teaching and communicating with students in STEM disciplines at the University of Wisconsin-Madison. In this paper we discuss and compare the results from a collaborative TEL project by examining the key instructional motivators and entry points for faculty
within the CoE’s and ICBE’s organizational context and culture. The challenges of motivating, supporting, and leading faculty adoption of new teaching methods, including technology, in a Research I decentralized higher education institution have been acknowledged by the ASEE Phase 1 Report. The initial TEL project in CoE funded the development of a math editor tool; while the initial TEL ICBE project developed a tool to facilitate giving feedback to students. Both tools were created within the open source course management system (CMS), Moodle. Using an open-source CMS provided opportunities to move beyond the fundamental requirements of a CMS, and create a place for faculty and students to connect, interact and engage using a variety of teaching and learning techniques.

Both the CoE and ICBE recognize the need to continue using effective teaching practices and tools to improve their learning environments and student achievement in the STEM disciplines. The approach used by each project partner reflects the different organizational context and culture that the instructors, tool developers, instructional and technical support staff are presumably influenced by. The contexts differ with regard to internal support and reward systems in place to motivate faculty to use instructional innovation and technology. There are also differences in the ability of external stakeholders, such as industry leaders and professional societies, to influence the adoption of specific curriculum reform measures. However, both projects aim to influence those faculty, who with compelling reasons and adequate support are willing to try new teaching methods and technologies.

Multiple methods of providing support and motivation for faculty users were tested in both projects.

Under the current TEL project, the CoE and ICBE are collaborating to support faculty participation and development in course design and pedagogical best practices with instructional strategies and tools common in STEM disciplines. Moodle was used by both partners prior to the TEL project as an open-source CMS because of its support of mathematical computation and options for collaborative workspaces which are important to all STEM disciplines. The use of Moodle and the shared goal of creating richer teaching and learning environments provided an opportunity to collaborate and share results from our implementation activities and evaluation.

The long-term outcome of the TEL initiative is to provide a more active learning experience that better prepares STEM students to successfully engage in the 21st century global economy. The ensuing implementation and evaluation approach for each project partner is influenced by the different motivations, needs and barriers of faculty in their adoption of one or more pedagogical tools. The TEL Engineering component of the project is a college wide initiative shaped by administrative leadership and connected to the professional engineering societies and accrediting body promoting engineering education innovation at an effective and scalable level. The ICBE component draws on the teaching experience and common objectives of faculty and staff across biology, chemistry, and physics in a collaborative development approach.
Project Goals

The objectives for the 2009-2010 TEL Project: *eCOW2/Moodle Enhanced Learning in Introductory Biology, Chemistry, Mathematics, Physics, Engineering, Language, Agricultural and Life Sciences* were to:

- generate broad faculty adoption of effective uses of instructional technology in STEM courses,
- develop Moodle tools for math computation and managing feedback to expand instructional capability, and
- demonstrate improved student learning experiences from the use of Moodle/eCOW2.

Briefly, the ICBE project was to build upon prior development of the Feedback Manager module and to assess its impact. The Feedback Manager module was one tool within the TEL Project focused on scaling up the use of eCOW2/Moodle within the CoE and CALS at an enterprise level. By providing a *surge* of faculty support and technical assistance the project sought to achieve wider adoption of the available tools in Moodle and integrate effective instructional design and delivery principles to positively affect student learning. Discussion of the two implementation approaches for each component will provide a comparison of the similarities and differences, in approach, context for use, challenges and opportunities in leading to faculty adoption and development of tools and pedagogical practices.

**TEL Project: Institute for Cross-College Biology**

**Purpose and Scope**

The purposes of the Cross-College Biology component were to create and assess a pedagogically sound tool to address the challenges of developing the critical thinking skills of students and promoting student success in large introductory courses. We chose a collaborative development approach to engage the instructors in the problem and to address the broad range of teaching styles and needs. We wanted to address this problem by harnessing the expertise of those who teach in these courses so that they will have ownership of the problem and the solution. Additionally, we hypothesized that our tool would be more useful and sustainable if we incorporated input from many diverse perspectives and allowed for varied ways of use.

The Feedback Manager (FM) was inspired by the tool designed by Harvard Physics professor Eric Mazur that made it easy to scan and group students’ written responses and communicate with the students. The FM concept was initially developed and tested by instructors in a large, team-taught introductory biology course on campus. During the design process input was solicited from chemistry and physics instructors who were also teaching large introductory courses. In planning meetings both with early faculty users and prospective users, as much emphasis was placed on designing effective questions as on the features of the tool. The tool was piloted by various instructors and there was a blossoming of diverse, innovative pedagogical uses as
each instructor used it to meet his/her instructional style, learning objectives, and time-constraints. This instructor input led in turn to numerous requests for specific customization of the FM software. A major part of the current year’s effort is to accommodate those requests and assess their usefulness.

Our approach to development and dissemination of this tool and use of technology in the classroom is consistent with the research on inspiring quality faculty work. Four factors have been described by faculty as important motives that make faculty life rewarding: autonomy, recognition, community, and the feeling of efficacy. Starting with a worthy problem that faculty can resonate with and have mutual purpose in is vital to developing a community of problem solvers. We targeted individuals previously involved in cross-STEM discussions, held since 2000, including those involved in the Science and Math for Biological Sciences Students (SyMBiosis) to further engage this community. The SyMBiosis group most recently discussed the requirements for critical thinking in Introductory Chemistry, Biology and Physics. Some of the faculty involved in these discussions are using FM as a vehicle for engaging students in critical thinking. The approach of finding mutual values and purposes develops faculty ownership in the project and utilizes the diverse teaching experiences of STEM faculty. In our project instructors have autonomy in the ways in which they chose to implement the tool based on their teaching style, objectives, course structure, and time constraints. They have helped beta-test new enhancements to the tool and gained recognition as part of the development team. We have tried to facilitate community building among the users and developers and the faculty are excited to be a part of the effort to improve STEM education. Faculty gain a feeling of efficacy as they assess the effect on students and continue to improve their instructional practice.

The Feedback Manager is a flexible add-on to the Moodle quizzing module. It allows instructors to efficiently ask open-ended questions on-line, receive students’ short written or drawn responses, categorize them for common characteristics, write feedback for each category, and send the relevant feedback in a semi-personalized e-mail to each student. The design of FM is based on the dual premises that writing helps students clarify their thinking and promotes higher-order construction of their ideas about a concept, and that getting feedback on their thinking and learning directly from the instructor is helpful to students. The education literature supports using low-stakes quizzing and frequent feedback to students as ways to motivate and validate student learning. From the instructor’s point of view, reading students’ written responses to well-designed questions provides much better insight into student learning and quicker identification of misconceptions than do multiple-choice/true-false questions. The tool facilitates this kind of faculty-student interaction, especially in large lecture courses. For more information about the tool, see Error! Hyperlink reference not valid. http://cals.wisc.edu/moodle/feedbackmanager/.
The ICBE team consists of a faculty member teaching in the large, two-semester biological sciences course, a staff member from the Center for Biology Education, two graduate student project assistants, an undergraduate, and a programmer. An additional instructional technology (IT) team member from the College of Letters and Sciences Learning Support Services was later added to the project team as it became clear that additional technical support for instructors and students was needed. As instructors join the project, their IT support person also became a collaborator and resource.

The instructor team initially began with ten introductory biology instructors who participated in development during the fall of 2008 and the spring of 2009. During the two semesters in the second year (2009-2010), the instructor team expanded to include instructors from: a non-majors biology course, an upper-level biology course, an honors introductory biology course, introductory chemistry, and introductory physics.

Supporting instructors in a collaborative development approach

Faculty support was recognized as a key component to the successful adoption of the tool from the beginning of the project. Activities were developed to promote the collaboration of STEM instructors across disciplines through sharing teaching experiences and discussing the goals and expectations they have for their students. In addition, individual support for the technology, as in the surge approach, is carried out by the project team and IT staff collaborators.

Instructor Team Formation and Activities:

- **Orientation workshops for instructors** which highlight the background educational research, student survey data from previous semesters, and provide activities to practice writing open-ended higher-order thinking questions. These workshops built a community of users and provided more information to faculty about best practices in scientific teaching.

- **Meetings between the instructors and the programmer** to learn how the instructors would tag responses. Our team began with the idea of being able to quickly sort responses and provide feedback. After talking to faculty we found that there are many methods of sorting responses and different perspectives on the types of feedback that should be sent to the student. We asked the faculty to bring in past student responses and to categorize them while talking through the process. Participating in this process gave great ownership to the faculty and helped the project team to develop better features and implementation strategies.

- **FM showcase forums** were held at the end of the first year to highlight the new tool and examples of how faculty had used the tool in year one. Instructors were invited based on the course they taught or because they had
previously showed interest in scientific teaching, using writing in the classroom, or are generally interested in teaching. Ideas for ways the tool could be used, improved, and implemented were solicited and some ideas were incorporated into the grant for year two.

- **Newsletter** with information about the tool and its implementation. The newsletter provides another method to communicate what various faculty are trying to do with the FM. The newsletter is sent out to the group of users, and is meant to inspire using the tool in new ways.

- **Website** ([http://cals.wisc.edu/moodle/feedbackmanager/](http://cals.wisc.edu/moodle/feedbackmanager/)) with suggestions for effective questions, feedback, based on literature and faculty experience. The website has been most useful for talking with interested people that are off campus. We are also using the Web site as a means to track our development progress.

- **Instructor focus groups** were used to better understand the instructor’s experience and to further facilitate connections between the users. Many adjustments to the FM were proposed in this context. We found it especially important that the faculty could talk about why they did not like FM or what they would change.

**Individual support:**

- **Visits of team members with faculty** before instruction began and during the instruction. These meetings fulfilled a variety of needs from technical support to writing good higher-order questions. There was a wide range of need for individual support from weekly to once a semester. We tried to make sure our constant presence was known, but did not interfere with how the faculty wanted to use the tool.

- **Class observations** by project team members to assist in implementation strategies. These observations provided a really important perspective of how the course is set-up, the teaching style of the instructor, and the current means of communication between students and instructor.

- **Building a support team of instructional technology staff** knowledgeable of FM at the department/college level. We had anticipated that instructors would need technical support for the FM, but we quickly saw that support was also needed for more general questions about Moodle as a course management system.

Both group and individual support was necessary for the success of this project. The group support provided a space for faculty to learn new ideas in pedagogy, learn new technical aspects of the tool, and to share their successes and challenges in teaching with the new tool. Our goal as a project team was to step-back and listen during these group meetings such that the faculty users could tell their story so that the other
faculty could learn by example. The individual meetings gave us a chance to get to know the instructors better and to address their needs more efficiently.

Project Evaluation

The TEL Biology team is assessing the effect of the tool on student engagement and learning through surveys, student focus groups, and field observations of participating course sections. We asked students about their experience with the quizzing, feedback, writing of open-ended responses, and their interaction with the faculty. Our initial impressions are that students think that feedback is important to their learning and that although writing is more work than multiple-choice questions, it is a valuable learning tool. Students even felt that writing on quizzes was helpful in preparing for multiple-choice quizzes. Student comments often included feedback for developing the tool but also provided evidence to instructors that the time spent providing semi-personalized feedback was beneficial.

Focus groups of faculty users and course coordinators are being used to assess the effectiveness of the tool and to discuss the variety of ways they have put it to use. In the focus groups, faculty are asked questions related to the development of the tool, the ease of use of the FM, how well FM helped them to achieve their teaching and learning goals, and what about their teaching or thinking about teaching has changed because of this experience.

Although the results from the faculty interviews are varied due to a small sample size and the diverse ways that faculty used the FM, we have some evidence that our approach is successful. Most of the faculty experimenting with this new tool were optimistic about its usefulness and were excited to be part of the development process. Some faculty have shared with us that reading student answers has provided a unique perspective on how the students understand the concept and has helped them to better understand the types of misconceptions student have about a concept. We have evidence that faculty have taken ownership in the initiative rather than just passive participants in our experiment. The faculty that were most involved with the development also became our best advertisement. One faculty member gave a teaching/learning seminar about his teaching, and included a description of Feedback Manager. Another faculty member enlisted the help of his postdoc to develop a better way of sorting student responses. Another instructor took the initiative to ask his students to test and write feedback on their experience of using the drawing tool. The students’ feedback was then shared with other FM users. Perhaps the most important piece of evidence that the instructors felt like part of the experiment is their extraordinary patience in the face of some frustrating glitches and unmet expectations that accompany beta–testing a tool.

As with any new tool there is a learning curve, particularly when development and implementation are occurring in the same semester. This led to some frustration and perhaps less buy-in by the users. Another challenge that we encountered was faculty not following their plan by not using the tool or not using the tool to its potential. As
a team we responded to both of these situations by providing more pro-active support and encouragement. However, while increasing the efficiency by which instructors can give feedback to students’ written responses, using the tool still requires considerable time and effort on the part of the instructors in preparing feedback comments. Therefore widespread adoption of the Feedback Manager tool is not expected; just an increase in numbers of faculty asking students to respond to questions in writing.

Further evaluation of the effect of the feedback, quizzing, writing and interaction Feedback Manager on student learning will be conducted during the second half of the TEL Project.

Recommendations for using a collaborative development approach to faculty development

- Recruit participants to test the new tool based on interest in the project and the common goal that is being addressed.
- Choose faculty who already use teaching methods similar to those the tool is targeting. The transition to the new tool will be easier for the tester, and thus they may get a better perspective on the capabilities of the tool.
- Encourage faculty to find an implementation strategy that works well for them and support them in their decision.
- Encourage all instructors in a team-taught course to participate.
- Provide a support structure for the testers including both technical and teaching support.
- Try to recruit faculty who are able to be involved in the project for more than one semester.
- Give those involved in testing a new tool the opportunity to voice their opinion and to see changes made if appropriate.

TEL Project: CoE/CALS

Purpose and Scope

The goal of the TEL project CoE/CALS component was to promote a steep adoption rate of eCOW2 in courses in the College of Engineering. Incentives to begin using the course management system was proffered by making direct technical and pedagogical support available to faculty. The objective was to use research-informed best practices to implement the activities and resources in eCOW2/Moodle to develop a targeted fifty (50) pedagogically sound courses to create a “tipping point” \(^7\) whereupon the practices become self-sustaining in the future. TEL project CoE staff and consultants identified potential courses and verified faculty interest in being part of the project. These courses were to be developed in three waves. The initial surge began immediately after the tech consultants were trained and took place during summer 2009. The second began as the fall semester started and the third and final occurred over spring semester with a winter break start. The courses in the first wave
were selected because the faculty teaching them had been early adopters of eCOW2 and were already using some of the basic features.

Developing the Team

To implement the “Surge” component of the project at the lowest possible cost, to avoid permanent hires, and to provide a personalized and scalable experience in pedagogical development, students were used extensively throughout the project. Two graduate students, each with expertise in both a STEM discipline and Education, were brought aboard to facilitate and lead a team of undergraduate students who would be trained as eCOW2/Moodle technical consultants. Together the lead consultants and tech consultants would help faculty learn to more effectively use the new course management system. Because the eCOW2 CMS was new to both teachers and learners during this training, the Surge team emerged with expertise spread widely between the undergraduate technical consultants, graduate student lead consultants, academic staff and faculty on the TEL team.

The goal of the training was to develop the technical and lead consultants to be able to interact with faculty to assist them in putting a course into the eCOW2/Moodle system. Specific learning objectives for the consultants included development of:

- Ability to use eCOW2 as a course management system
- Confidence interacting with faculty
- Ability to select and implement eCOW2/Moodle tools appropriate to course goals and objectives
- Recognition of key teaching and learning best practices
- Effective use of a team communication and project management system

Nine tech consultants were trained during the initial sessions. These individuals continued learning Moodle individually and collaboratively as they worked on projects throughout the summer. As the fall semester began, there was some turnover in student employees, and the new recruits were assimilated into the TEL project by working on course project teams.

A survey (Attachment A) of the technical and lead consultants was conducted at the end of the training to evaluate the achievement of the learning goals. A focus group was conducted at the end of the fall semester to gather additional insights into the overall experience of the technical consultants and what steps might have been taken to better prepare them for their role in supporting faculty pedagogically and technologically on this project.

Surge Implementation

Each course had a lead consultant and one or two technical consultants assigned to it. The lead consultant had an initial meeting with the faculty to learn more about the course and the how the faculty used teaching and learning principles effectively. Following a backward design approach a series of questions were asked about course
logistics, content, and assessment. Instructors were encouraged to reflect on their achievements in developing the course and areas they would like to improve. During this 45-minute meeting, the lead consultant was able to develop an understanding of the course and current technologies used in the course, then begin to formulate ideas about areas that might be enhanced with some of the new technologies in eCOW2.

The lead consultant next met with the tech consultants to share the results of the initial consultation with the faculty member and brainstormed ideas for developing the course in eCOW2. Because this team-based project required effective communication, it was important to create a virtual central location using a project management software tool to manage projects and team collaboration. Each Surge course could be created as an individual project where the lead consultant and tech consultants assigned to work on the course could post messages, upload documents, create wikis, and generally communicate and work on the project. If the course team ran into obstacles, they could use the project management space to ask questions of any of the TEL project team. This created a repository of new learning about eCOW2/Moodle and project documentation so all of the courses were developed with the shared knowledge of the entire TEL team.

Based upon the needs of the faculty, different development strategies were adopted to design a sample course implementing eCOW2/Moodle technologies. For example, some faculty wanted to see all of the features of eCOW2 and determine if they were effective teaching and learning tools for their courses. Others who had explored eCOW2 previously and had used the CMS as an online syllabus were now interested in seeing some of the more advanced features. When the course ideas were in place and ready to show to the instructor, the tech consultants led the next meetings with faculty. Instructors were able to see all of the possible Moodle resources and activities that they could use and decide which they wanted to employ for the upcoming semester. Additionally, tech consultants were asked to move courses from other course management systems to the new eCOW2 system. The role of the tech consultants was to assist the faculty to adopt effective TEL practices using the available tools and technologies within the CoE or on campus, and to train the instructors, and often the Teaching Assistants (TAs), so that they could maintain the course on their own throughout the semester. Some faculty indicated that without the one-on-one consulting in terms of using eCOW2 they would not have been able to transition to the new CMS platform and use it to meet their teaching goals.

The process from the initial meeting between the lead consultant and course instructor to the point where the instructor felt comfortable maintaining their course in eCOW2 was repeated for each Surge course project. During the initial Surge in summer 2009, twelve courses were completed. As the tech consultants became more skilled, even with fewer hours worked during the fall semester, nineteen courses were completed. At this time the Surge project is on target to reach the “tipping point” of fifty courses.
Faculty Adoption

The Surge model implemented to promote rapid adoption of eCOW2 by CoE faculty is based upon the use of instructional technology in support of sound pedagogical practices informed by research and best practices from the educational sciences and engineering education research literature referenced in the ASEE Phase I Report\(^1\). How we determine success in terms of faculty adoption of eCOW2 can be measured with a number of different metrics. The most straightforward approach in terms of the delivery of eCOW2 as an enterprise CMS would be to simply count the number of courses that have been transitioned to the eCOW2/Moodle platform as a result of the Surge component of the TEL Project. However, because our desired outcome is to sustain the effective use of course design elements with pedagogical practices that incorporate active learning, engagement, collaboration and assessment to improve student learning, our measure of success in terms of faculty adoption is more complex. As studies indicate, many factors contribute to implementation of successful instructional innovations\(^9\). In a survey of faculty we have gathered feedback on the effectiveness of the Surge approach in terms of technical assistance provided, support for use of research-based pedagogical practices, use of the eCOW2 system overall, and faculty preferences for professional development opportunities offered to sustain TEL.

A major goal of the surge team has been to help instructors understand and use the eCOW2/Moodle software features available to support their instructional strategies and pedagogical practice. We presume that courses in which “active learning” and other interactive learning activities are being supported with the tools available overall create a learning environment that is more engaging for learners. We further assume then that the use of these tools in the TEL project courses suggests the surge team has been successful in influencing faculty to use these tools. Faculty (Attachment B) and student (Attachment C) surveys and focus groups were conducted to gather evidence to support or refute these assumptions.

Technology Use and Development

The state of e-Learning within the College of Engineering (CoE) and other science, technology, engineering and mathematics (STEM) disciplines at the University of Wisconsin - Madison includes the use of a variety of technologies to enhance course offerings. Faculty are using web streaming video lectures, podcasting audio lectures, and various software tools, including Articulate, Camtasia, Elluminate, eTeach, and Mediasite to synch classroom materials with audio and video presentations. Web-based resources such as MySpace, YouTube, Facebook, Microsoft Live Meeting, My Web Space, wikis and blogs are being incorporated by faculty to enhance teaching and learning activities. These web-based technologies are being used alongside other instructional technologies such as clickers, videoconferencing, teleconferencing, and the use of specialized engineering and computer aided design (CAD) software and simulation tools.
One reason Moodle was selected as the CMS for developing eCOW2 is its extensive support of interactive and collaborative learning activities. From the research and literature on how students learn in the STEM disciplines, we make the assumption that these kinds of “active learning” activities have a higher value for students than viewing static materials online. Since a major goal of the surge team relative to faculty adoption has been to help instructors understand and use these active learning tools, we developed a Moodle “report” which helps us track the use of various Moodle tools in courses developed with help from the surge team versus courses which did not receive such help.

The preliminary report on tool usage attempts to capture two different forms of activity. First is the activity of instructors adding features to their courses which they believe will help students to learn the course material. Second is the use of those activities by students.

This chart shows the number of each learning activity that instructors assigned to their students on a per-course basis. The chart reflects learning activity in 24 surge courses compared to that of the 188 non-surge courses. For example, among the surge courses there were on average more than four quizzes assigned per course whereas in the non-Surge courses only about half of the courses had a quiz at all. Since we assume from the educational learning research that frequent quizzing helps motivate students to keep up with their course work, we conjecture that the surge team effort helped to improve student learning by assisting instructors in their use of the online tools to add learning activities to their courses. With our measurement tool built as a Moodle module, it can automatically measure the number of assignments, and responses to each Moodle “activity”. Note that in Moodle, every activity can be graded and every assignment of an activity results in a potential grade book entry.
Student Learning

One of the goals of this component of the TEL project was to identify meaningful measures to demonstrate that student achievement and learning is positively impacted from the use of instructional methods and content delivery approaches supported by the active learning tools and features within eCOW2/Moodle. A total of 892 students were enrolled in one or more of the Surge courses. All enrolled students in one or more of the TEL project surge courses were asked to respond to a survey assessing their learning experience in a specific surge course. A variety of learning style preferences are reflected in the student responses to date. The TEL Project is at its midpoint and a final analysis of the results will be prepared and used to evaluate the overall success of the project and areas to improve upon after the June 2010 completion date. Preliminary results from the assessment plan strategies are being used as a formative assessment of our faculty support and development efforts in terms of faculty adoption of the eCOW2, use of instructional tools such as the Feedback Manager, or other features of eCOW2/Moodle to support effective technology enhanced pedagogical practices to provide innovative STEM education. For example, when asked which teaching challenge eCOW2 was being used to address, half of the faculty surveyed (N=8) indicated it was to make lectures more engaging, give prompt feedback, and to provide students with practice or reinforcement. Measures of student satisfaction and learning effectiveness with the various instructional tools and pedagogical practices will continue to guide the course design, development, delivery and evaluation processes.

Discussion and Conclusions

Supporting faculty in the use of technology requires a variety of approaches to address the various motivations for using technology and the ensuing attitudes toward using technology in teaching and learning. Hagner describes different types of instructors as first wave and second wave. First wave instructors are entrepreneurial and develop the technologies on their own, while second wave instructors are more risk adverse and require more local support. Both of the project approaches address the second wave audience.

The ICBE project involves some degree of risking taking for participants because we are developing a new tool. The faculty involved are more motivated by the pedagogy than new technology (a characteristic of second wave faculty), thus they require a lot of support to reduce the anxiety of trying a new tool. Face-to-face support from the project team and IT staff at critical moments was essential to the success of developing a new tool. Additionally, it was vital to have peer-to-peer sharing opportunities to build community. We have found the collaborative development approach to be extremely useful in developing new tools because the development is driven by a need to improve pedagogy, rather than to simply use new technologies. For inter-disciplinary initiatives when there is no obvious administration structure, the collaborative development approach provides structure for the faculty to build leadership and to take ownership of the project.
The “surge” approach initiated by the CoE Academic Affairs unit is also aimed at Hagner’s second wave faculty. Tools for instructors to use were for the most part already developed and the instructors were given local support by a surge consulting team brought on specifically for the project implementation. In order to effectively create the tipping point, we realized that we needed to offer support to all faculty using the eCOW2 tool, not just to instructors in the 50 targeted courses. An email and phone help desk were set up and supported by the student consultants. Online support materials were continually developed and a support website was created to host these materials. Interestingly, the faculty survey indicated that the two most favored methods to engage in professional development were one-on-one technical consultations on the specific tool and Brown Bag sessions. Similar to the ICBE collaborative development approach, the CoE is exploring ways to generate a faculty learning community to foster peer-to-peer instructional learning. While motivation for the administrative team and faculty participants was internal, there was also an external component supporting a peer-to-peer collaborative development approach to identify the performance elements of effective teaching in engineering aligned with the engineering education innovation literature from ASEE, National Academy of Engineering, National Science Foundation, and examples from peer engineering institutions.

In conclusion, if universities as a whole wish to move toward greater use of effective instructional technology, the two approaches used in this collaborative TEL project may, given the particular context, serve as effective implementation strategies. Survey and focus group feedback indicates that a combination of the two approaches is likely the most effective, and we shall continue to evaluate whether these approaches effectively promote sustainability. Sustainability of new technologies in the STEM disciplines will be more likely if an organization can provide a dedicated instructional and information technology support staff along with relevant professional development opportunities that help faculty to better use the instructional resources available. Opportunities and support for faculty to lead the development of tools and teaching strategies will increase sustainability. Open-sourced tools like Moodle support this type of innovation. TEL Project partners will continue to explore connections with campus partners and external STEM educational research and innovation resources that offer solutions to meet faculty needs for support, development and technical assistance.

Acknowledgements

We wish to recognize the following Sponsoring Deans and key contributors to the TEL Project: eCOW2/Moodle Enhanced Learning in Introductory Biology, Chemistry, Mathematics, Physics, Engineering, Languages, Agriculture and Life Sciences for their contribution to exploring new opportunities to create and sustain technology enhanced learning in STEM disciplines.

UW- Madison Sponsoring Deans:
Dean Paul S. Peercy, College of Engineering
Dean Margaret M. Molly Jahn College of Agricultural and Life Sciences

UW-Madison Key Contributors
Greg Moses, Professor, College of Engineering
Robert Kohlhepp, Director, Computer Aided Engineering, College of Engineering
Regina Nelson Lead Technology Consultant and Ph.D. candidate, College of Engineering
Sandra Shaw-Courter, Director, Engineering Learning Center, College of Engineering, retired.
Tim Tynan, Lead Technology Consultant and Ph.D. candidate, College of Agricultural and Life Sciences

Bibliography


3. C. H. Crouch, J. Watkins, A. P. Fagen, and E. Mazur, “Peer Instruction: Engaging Students One-on-One, All At Once,” in Research-Based Reform of University Physics, edited by E. F. Redish and P. J. Cooney (American Association of Physics Teachers, College Park, MD, 2007), Reviews in PER Vol. 1,


Attachment A: TEL Project Consultant Survey

Consultant Training Survey

The purpose of this survey is to gather feedback from the lead and technical TEL project consultants to determine additional training needs and ways to support you in carrying out your consulting role with faculty on the TEL project.

1 Supporting quality teaching and learning with technology requires a foundational knowledge of these best practices. Please comment on how effective your training experience was at conveying the overall goals of the TEL project and in providing the context for effectively consulting faculty on TEL best practices. * required

<table>
<thead>
<tr>
<th>TEL project goals</th>
<th>Very Effective</th>
<th>Effective</th>
<th>Neutral</th>
<th>Ineffective</th>
<th>Very Ineffective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching and learning best practices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using Moodle/eCOW2 tools to support effective STEM teaching and learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective TEL project communication strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective TEL project consulting strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2 Please comment on the effectiveness of the eCOW2 technical sessions in providing practice and reinforcement to support your learning to use the Moodle/eCOW 2 course management system. * required

<table>
<thead>
<tr>
<th>Strategies and Tools Table</th>
<th>Very Effective</th>
<th>Effective</th>
<th>Neutral</th>
<th>Ineffective</th>
<th>Very Ineffective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math Editor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forums/Chats/Groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grading Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback Manager</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quizzing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3 As a result of this training, how confident are you in your ability to: * required.

<table>
<thead>
<tr>
<th>Use eCOW 2 as a course management system</th>
<th>Very</th>
<th>Somewhat</th>
<th>Neutral</th>
<th>Not very</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articulate your consult</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. How, if at all, do you see your role in the TEL team project as a design experience?

5. What additional questions or training needs do you have after this training?
6. Overall, what else would you like us to know about this week’s TEL Team Training experience?
Attachment B: TEL Course Enhancement Faculty Development Survey

Technology Enhanced Learning (TEL) Services Survey

The purpose of this survey is to gather feedback on the resources, both face-to-face and online through the eCOW2 instructional support site (ecow2@engr.wisc.edu) designed to help faculty develop the skills and knowledge needed to use the Moodle course management system to support their teaching goals.

1. Please describe your level of experience with Moodle and/or eCOW2 prior to accessing the TEL support services or eCOW2 website. *

   -- Please Select --

2. The goal of the TEL project is to enable faculty to adopt effective TEL practices using available tools and resources to improve student learning outcomes. Please tell us if the consulting resource and/or eCOW2 website helped you address one or more specific teaching challenges with the use of TEL? Select at least 0 responses.

   - Making lecture more interactive and engaging
   - Demonstrating complex concepts
   - Providing students with practice or reinforcement
   - Focusing students on real-world problems or tasks
   - Giving prompt feedback
   - Using alternatives to traditional assessment
   - Other, please specify

3. How effective are the TEL project consulting services to assist you in using Moodle/eCOW2 to further develop your own course and teaching goals?

<table>
<thead>
<tr>
<th>Goal</th>
<th>Very Effective</th>
<th>Effective</th>
<th>Neutral</th>
<th>Ineffective</th>
<th>Very Ineffective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 1: Outline and give access to course resources and activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal 2: Address common course questions, meet challenging learning objectives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal 3: Provide feedback; give and grade assignments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal 4: Enhance lectures, make learning active</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal 5: Support individual coursework</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. How effective are the eCOW2 tutorials on how to use the Moodle/eCOW2 tools to further develop your own course and teaching goals?

<table>
<thead>
<tr>
<th>Goal 1: Outline and give access to course resources and activities</th>
<th>Very Effective</th>
<th>Effective</th>
<th>Neutral</th>
<th>Ineffective</th>
<th>Very Ineffective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 2: Address common course questions, meet challenging learning objectives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal 3: Provide feedback, give and grade assignments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal 4: Enhance lectures, make learning active</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal 5: Support individual coursework</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal 6: Facilitate teamwork and collaboration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Goal(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. After using the TEL support services, either face-to-face consulting and/or online via the eCOW2 website, how confident are you in your ability to align your teaching goals with learning objectives and appropriate assessment strategies?

- Very confident
- Somewhat confident
- Neutral
- Not at all
- Other, please specify

6. Please comment on which Moodle tools or resources you are likely to incorporate into your course, if any.

7. What additional questions or information needs do you have about using Moodle/eCOW2?
8. Which of the following resources would you likely use to support your teaching and TEL goals?

- [ ] One-on-one course development consulting
- [ ] One-on-one technical consulting on using Moodle more effectively
- [ ] Brown Bag on using performance criteria and assessment strategies to measure student learning
- [ ] Brown Bag on using tools to enhance lectures and support active learning
- [ ] Brown Bag on tips for electronic course management
- [ ] Brown Bag on tools to facilitate collaboration and teamwork
- [ ] Other, please specify
Overall Course Experience

The purpose of this survey is to assess whether your learning experience in this course was enhanced by the use of instructional methods, learning activities, and instructional tools resulting from the use of eCOW2. Your participation in this survey is voluntary and the individual responses will be anonymous. The aggregated data will be used to evaluate ways to improve the design and delivery of courses using technology enhanced learning in blended and online courses at the UW-Madison College of Engineering.

You are being asked to take this survey because you are enrolled in one (or more) of the following courses: CALS Hort 120 CALS InterAg 155 CoE CEE 442 CoE ECE 601 CoE EMA 201 CoE InterEgr 160 CoE ISyE 671 CoE ME 370 CoE MSE 350 CoE NE 271 The results of questions in this section are based upon your overall course experience and your perceptions of what you learned from the course.

1. You have been invited to participate in this survey because you are enrolled in one (or more) of the TEL Project "surge" courses listed below. Your responses to this survey should reflect your experience in the course you select from the list below. * required

   - CALS Hort 120
   - CALS InterAG 155
   - CoE CEE 442
   - CoE ECE 601
   - CoE EMA 201
   - CoE InterEgr 160
   - CoE ISyE 671
   - CoE ME 370
   - CoE MSE 350
   - CoE NE 271

2. Which factors had a significant effect on your learning in this course? * required

<table>
<thead>
<tr>
<th></th>
<th>Very Significant</th>
<th>Significant</th>
<th>Neutral</th>
<th>Insignificant</th>
<th>Very Insignificant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction with content</td>
<td>☑</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Interaction with Instructor(s)</td>
<td>☑</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Interaction with other students</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Use of course supported interactive tools</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
</tr>
</tbody>
</table>
3. As a result of this course, how confident are you at relating course ideas and concepts encountered in this class to other classes within this subject area? * required

- Very confident
- Somewhat confident
- Neutral
- Not very confident
- Not at all confident

4. How confident are you that you understand the content and material covered in this course?

- Very confident
- Somewhat confident
- Neutral
- Not very confident
- Not at all confident

Learning Objectives

Learning objectives describe what students are to gain from instruction. Objectives should describe student performance in specific measurable terms.

5. Based upon your experience in this course, please indicate your level of agreement with the following statement: The stated learning objectives described what students are expected to know or be able to do as a result of the course.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

6. In your experience, the stated course objectives for this course appropriately reflect your learning gains from participating in this class? * required

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

7. Reflecting on your experience, which learning activities contributed most to your learning?

Assessment and Measurement

The goal of effective assessment is to measure students' accomplishment of the course learning objectives to provide evidence of student learning outcomes.

8. Based on your experience in this course, please indicate your agreement with the following statement: The types of graded assessments (homework, tests, quizzes, reports) in this course fit well with the learning objectives and activities (lectures, readings, assignments, projects).

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

9. How effective was the performance criteria used for graded assignments in helping you understand how you would be evaluated for your work and participation?

- Very Effective
- Effective
- Neutral
- Ineffective
- Very Ineffective
10. How effective was the feedback you received on your graded work in helping you to manage your own learning?

- Very Effective
- Effective
- Neutral
- Ineffective
- Very Ineffective

**Learner Engagement**

Learner engagement refers to the meaningful interaction between the instructor and students, students with other students, and between students and course materials. Learning activities should engage students in the course content to facilitate their achievement of the stated course learning objectives.

11. Based upon your experience please indicate your agreement with the following statements:

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>This course provided opportunities to demonstrate what I know, and to receive suggestions for improvement.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>This course gave me access to tools that helped me work more efficiently.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>This course set high expectations for communication with my instructor and with other students</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>This course gave me access to tools that facilitated my engagement in the learning activities.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

**Course Technology**

The College of Engineering has adopted instructional tools

12. Please indicate how useful each of the following aspects of the course was to your overall learning outcomes. * required

<table>
<thead>
<tr>
<th>Very Useful</th>
<th>Useful</th>
<th>Neutral</th>
<th>Useless</th>
<th>Very Useless</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion forums</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Feedback from faculty on assignments</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Low stakes quizzes (or other assessment activities)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Chat</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Wikis</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Web content</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
13. Please comment on any aspect of your learning experience in this course you would like to share.