Digital resources to excite students about soil science

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Abstract
The Soil Science courses at Purdue University have been a great recruiting tool for the department and have encouraged many students to select careers in soil science. Placement of soil science students after graduation has been approximately 95%. In recent years, new instructional technologies such as Student Response Devices and Adobe Acrobat Connect Pro® (Adobe Connect®) have allowed instructors to increase the students' engagement in the learning process. Individual Student Response Devices are used in lectures to assess learning. Based on input by each student, the class immediately discusses topics that are not clear resulting in enhanced learning. Adobe Connect® provides a way for instructors to tutor students via the Internet. Faculty arranges a time to be available at a specified Website to help students with homework assignments or exam preparation. The student simply accesses the Website and is immediately in the instructor's "meeting room" where students chat using text boxes and faculty can be seen and heard as they discuss the course material. Student reaction to the Student Response Devices and the On-line Tutoring has been positive and it has increased students' ratings of our courses, improved course grades, and enhanced student interest in Soil Science.

Key Words
Student response device, on-line tutoring, interactive learning, active learning.

Introduction
At Purdue University, there has been a long commitment to engaging students in the study of Soil Science by providing students a Soils Resource Center (open 40 hours per week) that utilizes a multitude of computer directed activities, individual tutoring, collaborative projects, and interactive lectures and discussions. Since the late 1970's, when students in the Introductory Soil Science course at Purdue University first began to use personal computers, technology and a team approach to instruction by the faculty have played major roles in helping students learn about soils (McFee *et al.* 1980). Today, students conduct their weekly lessons in a Soils Resource Center equipped with Internet-based lessons and surrounded with a multitude of displays and experiments directly related to each unit's instructional objectives (Figure 1). In addition to the many opportunities for collaborative, active learning in the Soils Resource Center, students in the Soil Science (230 students annually), Forest Soils (45 students annually), Soil Fertility (65 students annually), and Soil Ecology (25 students annually) courses have a new instructional technology tool for the course lectures. All students enrolled in these courses have an *e*Instruction classroom performance system (CPS)® pad or "clicker" that allows them to respond to the instructor's questions individually. When the instructor poses a question in lecture, each student answers using his or her clicker. Immediately, a histogram is projected that tells the class and instructor how well the students understood the concept (Figure 2). This encourages the lecturer to focus on helping those students who did not understand the concept rather than assuming students are understanding and keeping up with the lecture because one or two students responded correctly.

Students in our soil science courses also have the ability to access the instructor via the Internet through Adobe Connect® to seek help with homework and/or prepare for exams. The use of Adobe Connect® makes the instructor available to the students from home (or anywhere) at a point in time when the students are most interested in learning – usually late at night before the homework is due or before an exam. Regular face-to-face help sessions and tutoring sessions are still offered but many students have schedules that do not permit them to come to these sessions. Late at night, on weekends, or at anytime convenient to the students, the instructor can use Adobe Connect® from a location of choice. The interactive sessions may be recorded and made available via the Web to students who cannot attend the face-to-face help sessions or the synchronous Adobe Connect® sessions. This access to the recorded "meetings" allows all students to learn from the instructor's and the other students' comments at a time and place of their choosing. In the Soil Fertility course, approximately one tutoring session is offered every two weeks depending on course assignments and the exam schedule. On-line tutoring has only been recently introduced in the other courses.

However, because of the effectiveness of this technique in the Soil Fertility course it has been used College-wide to tutor students in math and chemistry the last two years with approximately 100 students participating annually.

Methods

The Student Response Devices (clickers) used for engaging the students during lecture are *e*Instruction® units, model number KGEN2EL from Denton, TX, USA; ISBN number 978-1-881483-71-1. The cost is $25.95 and can be used in multiple courses. The hand-held device uses infrared (IR) or radio frequency (RF) to transmit student responses to questions during a lecture (Educase 2007). Most clickers in use today are RF because they are faster and require only one receiver to be mounted in the classroom (Simpson and Oliver 2007). Many of the response devices allow for multiple choice responses (A through E), true/false, and numeric answers on a 10 digit numeric pad, which consists of a power switch, serial number and send button (Caldwell 2007; Simpson and Oliver 2007). The student must register their clickers with the unique serial number that each clicker carries and student ID (Duncan 2007). The clicker transmits the student responses to a portable receiving unit which transmits the student answers to a computer in the lecture room. Results from the entire class are displayed as a histogram on the projection screen. The histogram maintains the anonymity of the students. There are grading tools associated with the *e*Instruction® software which allow the instructor to specify the correct answer so student responses can be graded and the information sent directly to an electronic grade book (Caldwell 2007), if desired.

These devices work well at Purdue University because they are easy to use and are supported by the University with receivers and software in every classroom. During a typical lecture from three to six questions are posed about the lecture material and every student responds to each question. Often, students are encouraged to have discussion with other students as they develop answers to multiple choice questions or questions requiring calculations and numerical responses. Histograms of their answers are shown to the class immediately following all of their responses. Presenting the answers immediately engages the students in lively discussions.

For On-line Tutoring, Adobe Acrobat Connect Pro® (Adobe Connect®) is the interactive software which allows the instructor to be seen and heard by the students over the Internet and allows the students to see PowerPoint® presentations, Word® or Excel® documents, video clips, websites or white boards on which the instructor can write using a Tablet PC. Students ask questions and discuss topics with other students and the instructor by typing in a chat box. Both the clickers and On-line Tutoring activities provide opportunities for active, collaborative learning and stimulate interest in the course material. Students do not need special software because all of the support is provided through the software used by the instructor. The only requirement for the student is an Internet connection and a computer that has speakers.

Results

Many efforts in recent years have focused on improving science education. In most cases, however, the lecture and textbooks remain a one-way communication of material. Despite the effort put into organizing an excellent lecture, research conducted by MacManaway (1970) showed that for 84% of his students, 20 to 30 minutes was the extent of their ability to concentrate in lecture. Clearly, the success of an exemplary lecture is limited by the passive role that students take in lecture (Duncan 2007; Elliot 2003). An interactive system such as personal response devices, colloquially known as “clickers”, can promote student-centered learning and maintain a high level of active involvement by each student, which results in more learning and classroom enjoyment (Elliott 2003; Wood 2004; Duncan 2007; Caldwell 2007; Educase 2007).

Clickers address two fundamental challenges in teaching: how to engage students and how to assess whether or not they are learning what you are teaching (Duncan 2007; Stowell and Nelson 2007). In a traditional lecture, the instructor may get an answer or two to a question or possibly a brave student asking for clarification. In our classrooms where clickers are being used, all students are required to participate in the question posed by the instructor and can do so anonymously and avoid risk of embarrassment. They become active participants and not merely passive listeners. Clickers give students and instructors immediate feedback concerning student understanding of the material being presented (Duncan 2007). A quick look at the summary of responses may encourage the instructor to present the information in a new way and provide a catalyst to trigger further discussion.

The overall trend found in the research literature indicates a positive attitude toward the use of clickers in the classroom. When students were asked whether they enjoyed using clickers, if they were helpful, and if they should be used again, over 70% responded positively (Elliott 2003; Simpson and Oliver 2006). Caldwell (2007) found about 88% of the students enrolled in an introductory non-majors freshman biology course at West Virginia University enjoyed using clickers in the classroom. Features the students liked most about the computer response system and the resulting class improvements included its anonymity, improved discussion and interactivity, reinforced learning, increased awareness of student comprehension and increased teacher insight into student difficulties (Roschelle *et al.* 2004). Wood (2004) also found that through the use of clickers students could better retain and apply concepts learned in lecture. In our soil science classes, we have found that 84 to 100% of the students felt the use of clickers was valuable to their learning experience and that 75 to 100% felt using the clickers kept them more engaged in the lecture. Variation in these responses was due to course, semester, and class size. To our surprise, students in a class of 25 students usually rated the use of the clickers the highest. We have also used them in classes of over 75 students.

Students learn most easily when they are receptive to learning. As they do homework or study for exams, the opportunity to access the instructor at a point in time when they have the most questions is extremely valuable. The Adobe Connect® On-line Tutoring (Figure 3) provides a tool that puts the instructor in contact with the students in their residence hall, library, or in their apartment while allowing the instructor to be in his/her office at the University or at home (or at any other location). The collaborative nature of both of these activities exposes students to the thought processes of the other students and helps them see how their responses and understanding of the material match those of their peers.

As seen in Figure 3, students are "chatting" with the instructor and are engaged in the learning process. Use of Adobe Connect® for On-line Tutoring was rated extremely high by the students – 4.5 out of 5.0. All students in the Soil Fertility course indicated that On-line Tutoring should be continued. Student comments included "very beneficial and convenient, easy to use, encourage other instructors to do this," and "audio very clear and easy to see PowerPoints® and other documents." Use of Adobe Connect® for On-line Tutoring allowed the instructor to bring up slides, websites, and homework documents with the added advantage of being able to write on these visuals or on a white board (Figure 3). In addition, the students see the instructor and hear his/her voice which has been noted by the students to be important. As pointed out by one of the students, "it's like the instructor is right there with you."

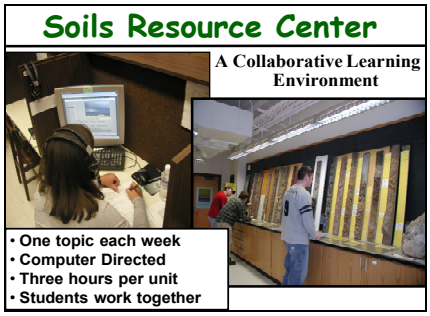

Figure 1. Soils Resource Center where students are actively engaged in learning.

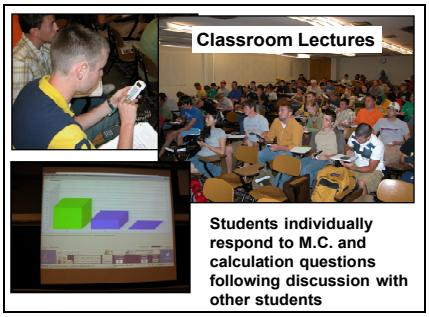

Figure 2. Using clickers in the classroom with a summary of student answers displayed on the screen following each student's response.

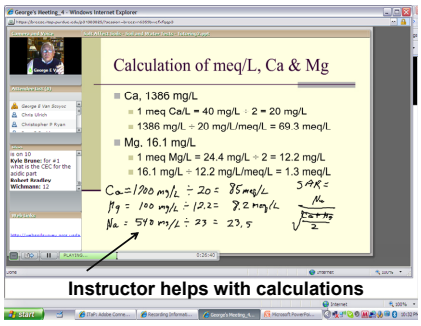

Figure 3. Computer screen showing On-line Tutoring using Adobe Connect® where students can see and hear the instructor and students chat via a text box to the left.

Conclusions

Instructional technologies like *e*Instruction® and Adobe Connect® allow instructors to engage students in the learning process and motivate them to excel in learning. In the Soil Fertility course where both clickers and Adobe Connect® On-line Tutoring were used, grades increased (A and B grades increased from 59%, a three year average, to an average of 75% for 2007 and 2008.) Course evaluations indicated that the quality of the course went from a rating of 4.4 out of 5.0 to 4.9 out of 5.0, and instructor quality and accessibility to the instructor went from 4.7 out of 5.0 to 5.0 out of 5.0. Students obviously liked using these instructional technologies and truly benefitted from them. Student interest in the soil science courses has remained high and post graduate placement of students (approximately 48 annually) in the soil and crop sciences is exceptionally good (95% had positions within six months after graduation).

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