Development of an On-Line Electronic Course in Environmentally-Sensitive Spray Applications

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Abstract

Software packages, course lesson plan topics, and a presentation format for an on-line engineering course for university credit were identified as a case study. Development criteria included the use of commercial software to minimize the effort required for course start-up. Consultation with faculty peers revealed that a dual software package would provide the best compromise between start-up effort and flexibility. Essentially, a high-end, web-instruction software package was recommended for course administration and tests, and a multimedia-developed web site residing on a department, or business-class server was recommended for presentation of the technical material. Navigation between the two packages, with appropriate security measures, was nearly seamless through the eyes of the student. One consultant advised that this dual approach should reduce the need to enter and re-enter technical material into the high-end, web instruction software as software upgrades were implemented from year to year, and that the window size to present the technical material would be greater for a typical web site compared to the instruction software. Investigation of high-end, web-based instructional software packages revealed the importance of faculty involvement in the selection process of university-supported packages, and this was in hindsight since the expensive package was pre-selected before this project started. The ability to easily share entered information among various software brands and/or versions should comply with Shareable Content Object Reference Model (SCORM) criterion. Further, an asynchronous course offering was prioritized to maximize flexibility in student involvement. The primary course objective was to educate pesticide applicators, regulators, sprayer engineers, and others on the environmental impact and corrective action to lessen atmospheric spray drift of applied crop protectants. Lesson plan topics were developed for modules with a progressive line of thought including (1) overview of spray drift problem, (2) dosage transfer of atomized materials (why we spray), (3) mass balance of applied spray material (how much is lost), (4) atmospheric transport (how droplets are carried away), and (5) best-management practices for reducing atmospheric transport. The presentation format was to link together a series of shortened technical segments, with attention given to developing salient technical points in sufficient depth with enough overlap with previous and subsequent sections to reinforce course continuity.

Introduction

With the paradigm shift in education and technology, everything from e-books to no books is envisioned. Reduction of knowledge into millions of common snippets without proper structure and academic rigor could result. Deconstruction of information into reusable chunks and snippets is a good concept with regard to information portability as long as the new constructs are academically sound. It is clear from the research that maximum retention occurs with information in smaller snippets (Bi, 2000). Short, interactive screens and clips aid in holding the attention of students (Strange, 2002).

Electronic communication via the Internet and the Worldwide Web is having a profound impact upon society and higher education (Hitchings et al. 2001). Web-based courses of instruction for graduate, undergraduate, technical programs and continuing education are springing up in many institutions of higher learning and in many private and commercial settings (Vogel, 2001). Comparisons between electronic-delivered and traditional teaching methods suggest that electronic-based learning and assessment are equal to or better than traditional methods (Bocij and Greasley, 1999). Hitchings et al. (2001) recognized that with these novel advancements in educational technology many are concerned with the quality and rigor of instruction - but he stated that the technology is just a vehicle. Various forms of web-based assessment methods do raise relevant issues such as access, rights, security, scheduling, delivery and some difficult issues such as student identity validation, performance certification, and academic integrity for university-level courses taught online for credit.

Driscoll (1999) suggested a needs-assessment with themes related to how people learn on the web and noted the following: (1) the importance of the systemic design of the instruction model, (2) the centrality of self-directed learning, (3) the strong relationship between educational themes, and (4) the identification of distinct kinds of web-based training. Web-based instruction raises questions on the educational effectiveness of (1) various sensory stimuli, (2) informational structure, (3) presentation method and technology, (4) exchanges between students and teachers and (5) academic rigor of the curricula.

Hitchings et al. (2001), Ess (2001), and Strohman et al. (2001) addressed course development, student and course evaluation and assessment, and best-practices development with respect to ABET's guides for developing outcome-based web material in biosystems engineering curricula. The consensus was that the use of the following guidelines is critical: (1) communicating course expectations from the start, (2) motivating student participation with scores, (3) ensuring initial student technological literacy, (4) monitoring student progress on some minimum interval, (5) recognizing and rewarding student excellence, and (6) encouraging student-student interaction. With today's high technology communications, many "e-savvy" people have high standards and expectations for sophisticated content as well as eye-catching graphics and visuals (Landon, 2002). However, user appeal and development cost must be balanced.
Another consensus is that the web-course should incorporate some level of academic

interaction between student and instructor.

Regarding the content of the course, agricultural chemical applications provide improved crop performance and benefit mankind immeasurably when used with appropriate understanding and controls. Education of applicators, regulators, and spray engineers regarding the factors affecting spray drift is a desirable goal that should aid in the reduction of undesired spray drift. Hewitt (2000) claims that even though some drift is practically unavoidable, a near-zero tolerance for any spray drift has developed. Biddleman et al. (1990) and others noted pesticide contamination in the Canadian Arctic, though none had been sprayed in that region. Biddleman et al. (1990) also noted chlordane being found in the atmosphere of the Northwest Territories, PCB's being found in the Arctic, and the presence of DDT in seal populations. Similarly, Matthews and Thomas (2000) noted the problems of off-target chemical movement on a local basis. Thus, there is a need for a course that emphasizes the reduced drift application of agricultural chemicals. Other than traditional on-campus students, off-site students involved with the chemical application process would benefit from a course on this subject. A web-format increases the opportunity to educate individuals who would otherwise not have access to the course.

Objectives

The primary objective was to develop a web-delivered, university-credit course on the subject of "Environmentally Sensitive Spray Applications." Specific objectives were to:

1. Identify best-fit software for course delivery in the current, university information technology structure,

2. Identify a step-wise sequence of topics for lesson plans for presentation in a web-based format, and

3. Determine the format of presenting the lesson plans in the identified software structure.

Methods

The effort began with discussions between the course developers (authors) and others who had web course experience, including Richard Strange, Robert Freeland, and Joann Logan, all of The University of Tennessee (UT), College of Agriculture and Natural Resources. Topics explored included course software, methods, presentation, delivery options, and discussion of the relative merits and weaknesses of different presentation avenues. Other meetings with representatives from the UT Distance Education and Independent Study Office included discussion of options for placing the course on the distance Education Blackboard link at www.utanywhere.com rather than the online@UT due to the more dispersed nature of the intended target audience. Meetings with the department computer support specialist aided in setting up an FTP and web site on the

departmental server and discussion of security issues.

Course Structure Considerations

The course was envisioned as an asynchronous format rather than a synchronous virtual classroom attendance. Convenience of taking the course by the student was given high priority. Consideration of whether to require some limited meetings or to have no face-to-face contact was given. Whether the course should be self-paced or have a specific, required schedule was discussed. Questions regarding the most effective and practical length, type, presentation format, and audiovisual aides and stimuli were asked.

A major consideration for developing a web-based course is the degree of instructor-to-student and student-to-student interactions. Should a web-course schedule be rigid? Should it run parallel to a traditional course offering? How often and to what degree should the instructor engage the student? Examination of various communications and interactivity including open forums, discussion boards, chat rooms, and e-mail were evaluated based on anticipated student response to homework, presentations, tests, and grades. Decisions regarding how to handle homework or tests, narrative problems, and complex mathematical problems and extent of manual grading and instructor comments were determined. Scheduling concerns for an asynchronous offering in which students are permitted to work at a self-directed pace but which still require completion by a deadline arose and how sequential modules might enable monitoring of student progress. Issues regarding what steps to take if a student falls behind were addressed.

The means and methods of student evaluation were addressed and related questions were raised. What activities performed by the student would constitute the gradable activities? What portion of the grade and manner of grading for each activity would be instructor graded versus software graded? How could hands-on activities associated with technology be performed on-line? Can they be simulated? Participation in the open-forum communications is commonplace for many students. Should it be included as a substitutionary grade for classroom participation in this course? How may examinations and question pools be developed, saved and/or reused? Will tests and questions have to be developed uniquely for the system and will they be transportable or can questions be imported into it?

Web-Course Platform Selection and Implementation,

A major goal of the development effort was to use commercial, web-based instructional software for course administration, yet integrate the use of multimedia software in the creation of a stand-alone web site for presentation of technical material. Strange (2002) advised that this approach would be more flexible and possibly reduce the need to re-enter technical material into the instructional software package. Some of the most important criteria for the instructor were the long-term user-friendliness and minimal amount of computer programming effort. This includes issues of ease of course development and of course re-construction from term-to-term. Ease of class and student administration features such as grading, access control, and management of class, student,

and instructor records was considered important in the course development. Redundancy and alternative avenues to access course material were believed to warrant consideration for some degree of independence. The use of different computer platforms, different-capacity internet connections by students, and the impact upon media selection were given consideration as was the desired window size for the web-site and any associated images across such channels of media for technological reasons. Compliance with the new Shareable Content Object Reference Model (SCORM, U.S. Dept. of Labor, Advanced Learning Technology Resource Center), a developing educational technology standard was considered. Finally, the ease of implementing software packages was a factor given consideration from the outset of the project.

Academic Integrity

Academic integrity is an issue that is always critical for any student, professor or institution. Considerable questions arose with regard to the use of the web and Internet for certified formal education purposes. It should be realized such integrity is not guaranteed to be free from corruption only with an honor policy and self-certification statement by the students.

Security Issues

The issues of computer security, student confidentiality and records security were questions that were addressed. Would separate login ID's and passwords be needed for the course as well as for the department and the University, which each have their own? How these questions relate to the structure of the course as either a course contained entirely within Blackboard or as a parallel course on Blackboard with a parallel independent website and link were addressed. Would the instructor and students communicate on these two branches and would these communications and the student records be secure and confidential while still being accessible to the target audience?

Course Academic Content

Development of the curriculum and integration of the curriculum into the platform of choice was a major consideration of the development process. What would be the structure of the course itself and what would be the general academic approach of the course? What topics of study would be included? Another important question that was considered was what level of academic rigor to employ in the course, given the diverse target audience backgrounds and their differing perspectives?

Issues of cost-effectiveness, timeliness, efficiency, adaptability, modularity, portability for future course offering, and course evaluation needed addressing for effective administration of the project. It was desired that the course could be developed, in place, and operational in one-and-a-half years with the aid of a half-time Graduate Research Assistant

Results

A wealth of information was drawn from the noted meetings and resulted in the following approach: Training resources provided by the Innovative Technology Center (ITC), the Department of Distance Education and Independent Study, the Library, and self-taught Macromedia Dreamweaver and HTML aided course development. The local contributors provided insight on the relative merits of different presentation methods as they fit within the university system.

Course Structure Considerations

A course administration package, Blackboard, and a multimedia package, Macromedia, were chosen for modularity, portability, and flexibility. The convenience and utility of Blackboard was recognized as the path of least resistance to handle administrative tasks. The flexibility and stand-alone capability of Macromedia for technical content was the easiest way for the course instructors to maintain some level of control over the entry of technical content, especially for future course offerings. It should be noted that other web course administration software packages, as well as other multimedia software exist, but the availability of the selected packages at the university weighed heavily towards their selection. Thus, faculty should actively participate in the selection process of software packages, especially web course administration software, because it was not clear to the authors that the Blackboard brand had the best portability, as compared to other packages that were openly SCORM-compliant.

The question of whether or not tests should be developed independently on the website or by use of the facilities in Blackboard was tempered with developmental time and cost constraints. Independent test development ensured portability but would have required increased time and effort to develop. Thus, Blackboard's test administration facilities were identified as the most efficient means of examining student comprehension. Other than Blackboard's standard true/false and multiple choice test question options, an essay option was identified for administering numeric-based problems, and open-ended test questions.

An asynchronous offering was chosen because it is perceived that the prime utility of the web lies as much in its convenience as in its content. A course can be devised for the convenience of the user as easily as it can be synchronous. Also, it was deemed that no face-to-face meetings would be required in that this would also infringe upon the utility of convenience to the user. Supervisory monitoring by the instructor is to be achieved through homework monitoring and grading, and by digital drop-box, or e-mail when occasions warrant the mass distribution of files or if individual correspondence is desired. The course was determined to be of normal semester duration, parallel to the traditional course-offering timetable with a schedule syllabus to be developed semester by semester. Thus, it is self-directed but not entirely self-paced. The student has a need to maintain a pace similar to that of traditional courses as well as with fellow classmates. The format is to be repetitive modular form containing background, examples with problems, homework, tests, laboratory-type exercises, and possibly with videos or technical process animations. It is believed that hands-on videos may be used to record and display relevant

demonstrations and eventually simulated animations may be used to create laboratory-type activities for the student on the course website. Length is to be twelve modules for a fifteen-week course.

Web-Course Platform Selection and Implementation

As a result of the myriad of complex and competing concerns addressed under Methods, the selection and development of an independent web-site skeleton at URL http://bioengr.ag.utk.edu/spraydrift has begun using Macromedia Dreamweaver pages. Content for several modules has been essentially developed, although it is not yet posted, and a general structure with necessary folder sets for all modules is in place on this site. It is intended that the site be accessed primarily through the "External Links" facility of the Blackboard system operated by the University of Tennessee's Distance Education and Independent Study Office at http://www.blackboard.utanywhere.com. The independent website is to be used in conjunction with Blackboards' excellent facilities for much of the routine course administration. In evaluating the software and the general platform, the merit of having the existing Blackboard system in place at the University of Tennessee addressed many of the issues of user-friendliness of the system to the instructor. The facilities for entering much of the course data are menu-driven pages or word-processing requiring little instructor programming effort. Blackboard has facilities for adding other external links and a variety of different multimedia components and also addresses the ease of course re-construction from term-to-term and has numerous administrative features for grading, controlling access, saving and manipulating records. The issue of resource redundancy and provision of alternate avenues to access course material, as well as the need for greater control and utilization in the visual presentation suggested the use of the independent web-site for window size and content presentation control. Pages and navigational aids are relatively simple at this point, yet effective. The use of differing levels of technology, browsers, and communications capacity also suggest the need for an independent web-site for technological reasons. The educational platform price, support, and availability of Blackboard are also issues that were considered when selecting this combined mode of delivery. Dreamweaver is a powerful, affordable, and compatible platform to be used with the existing course administration package found in Blackboard. SCORM compatibility was considered but deemed to be unresolved in that Blackboard is apparently not fully SCORM-compliant.

The various forms of instructor and student interactions possible through Blackboard and via the web on the course website provide the necessary pathways for communications between instructor and student. The open forum discussion available via Blackboards' "Discussion Board" should be an excellent tool for instructor-led discussion or student-initiated inquiries or comments, as permitted by the instructor, regarding homework, lecture notes, etc. The instructor will probably interact most with the student by means of grading and comments on student-submitted homework. When problems arise, an e-mail response may address questions, concerns, or comments by either student or professor. A student who falls behind should have essentially the same level of assistance as a student present on campus in such cases.

It was deemed that homework would be a self-directed effort with preliminary study of lecture notes, cited references, external links, example problems, homework problems and assessments to guide the student through the material. The tests are to be taken on the Blackboard system's provisions for "Assessment" but homework would not count in the grading. Narrative and essay problems may be used in Blackboard but would require independent manual grading by the professor or assistant. Any complex mathematics problems requiring lengthy work would normally require proofs rather than a mere selection of choices, fill-in-the-blank, or match without any proof. The latter is actually more rigorous than standardized testing of engineering fundamentals, or for engineering professional licensure. Instructor feedback with the test will constitute a major interaction between the student and instructor. Examinations on Blackboard provide automatic feedback to the student on any test that is taken. Positive participation in Blackboard's "Discussion Board" is deemed a significant activity that shall be graded. Appropriate frequency, duration, relevance, clarity, novelty, insight, enthusiasm, and reasonable manner are all considered noteworthy in terms of contributing to the forum. The question of whether and how tests and question pools be saved or reused remains unanswered for the moment.

Academic Integrity

The University of Tennessee academic honor policy and self-certification statement by the students is warranted as a start towards ensuring course integrity. However, the instructor should address problems of academic integrity on a case-by-case basis – just as classroom issues are addressed. Asking open-ended questions that have somewhat unique answers should help reduce the copying of answers from other sources. There are, in fact, automated means of comparing essay responses now. Essays and mathematical problem solving will probably have to be graded by the instructor as a rule. Though the workload on an instructor or grader is magnified with this approach, uniform grading by a single person should aide the detection of inappropriate collaboration.

Security Issues

The issue of computer security is primarily being handled by use of a network identification and password, both on the Blackboard site and on the departmental FTP site. The web-files reside on a read-only site for users who access the http web-site directly. Student confidentiality and records security will be addressed by use of the Blackboard facilities in conjunction with the traditional facilities for such record keeping.

Course Academic Content

The course will provide a scientific approach on the application of agricultural spray technology with an emphasis toward minimization of environmental impact. An outline for the course is as follows:

" Environmentally-Sensitive Spray Applications"

A. Introduction to Environmentally-Sensitive Applications

Module 1 General Overview of Pesticide and Herbicide Usage

Module 2 Documented Atmospheric Transport of Applied Sprays
Module 3 Optimization of Pesticide Application for Minimization of Spray Drift and Subsequent Environmental Impact.

B. Dosage Transfer of Atomized Materials

Module 4 Spray Deposits resulting from Applied Atomized Materials

C. Mass Balance of Applied Spray Material

Modules 5 and 6 Importance and Methods to Determine Mass Balance

D. Atmospheric Transport of Spray Material

Module 7 Droplet Size, Velocity and Trajectory
Module 8 Height of Application, Air-Assist Fans, Modified Trajectory
Module 9 Weather (lateral wind, atmospheric stability and conditions)
Module 10 Spray Methods and Atmospheric Transport

E. Best Management Practices for Reducing Atmospheric Transport

Module 11 Best Management Practices for Ground Applications
Module 12 Best-Management Practices for Orchard Applications

Conclusions

Development of a web-based university course, and specific direction taken when various questions arose, was strongly dependent upon the specific structure and software packages supported at a given institution. A case study of one course of action concluded the following:

- Institutional support for course development is abundant for providing several alternatives to post course material
- Beyond the logistics of posting course material, addressing hard questions of how students best learn via the web, course structure, academic integrity, and security issues were addressed by instructors
- Use of a high-end, web instruction software package, supported by the university, provided the easiest and quickest method for course administration and testing, but limited the presentation window of technical material, and limited course content portability if the software was not SCORM compliant
- Linking the high-end, web instruction software to a multimedia-developed web site residing on a department or business-class server aided the instructor in developing and maintaining course content
- Selection of an asynchronous course format required the establishment of milestones to assure that the course had some degree of structure for inter-student and student-instructor interactivity of a common subject
- An instructor should structure the course for a unique student response to some test questions to aide academic integrity
- Content of the course should be presented in sections small enough for students to understand the concepts at hand, and the sections should contain enough overlap with previous and subsequent sections to maintain a level of continuity.

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Observation of software strengths and weaknesses were made by the authors from an their instructor viewpoint, and may or may not coincide with the opinion of others involved with the use and selection of university-supported software packages.