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Impact of Two Course Content Delivery Systems on Student Learning

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Impact of Two Course Content Delivery Systems on Student Learning

Abstract

In 2007, a USDA Higher Education Challenge Grant funded the creation of a Virtual Education Center (VEC) for Biorenewable Resources at three partner land grant institutions. Three new courses are taught through the VEC, each using multiple instructors and exchanges of video lectures between sites. The most heavily subscribed of these is a graduate survey course entitled Fundamentals of Biorenewable Resources. In this paper, we report on comparisons of two online delivery methods used in the fundamentals course: 1) a standard video lecture using a tablet computer, and 2) a self-contained menu-driven autotutorial presentations (MDAP) delivered via Adobe Flash. In both cases, the module covered production of corn, soybean, hay and forage, and short rotation woody crops, as well as biotechnology basics. The two versions contained nearly identical academic content. The module was taught during weeks 9 to 11 of the course, allowing students to be sorted based on prior course performance to ensure the two groups were academically similar. Student performance data from the course were collected through WebCT assessments (quizzes and an exam) in spring 2010 and statistical analysis was used to determine student learning differences.

Keywords

Biorenewables, distance education, biomass production, Smartboard lecture, Flash

Disciplines

Bioresource and Agricultural Engineering | Engineering Education

Comments

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Impact of Two Course Content Delivery Systems on Student Learning

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Abstract. In 2007, a USDA Higher Education Challenge Grant funded the creation of a Virtual Education Center (VEC) for Biorenewable Resources at three partner land-grant institutions. Three new courses are taught through the VEC, each using multiple instructors and exchanges of video lectures between sites. The most heavily subscribed of these is a graduate survey type course entitled *Fundamentals of Biorenewable Resources*. In this paper, we report on comparisons of two online delivery methods used in the fundamentals course: 1) a standard video lecture using a Smartboard, and 2) a self-contained Flash teaching module. In both cases, the same biomass-production-focused content was presented. This part of the course occurred eight weeks into the 15-week long semester, allowing us to sort students based on prior course performance to ensure the two groups were academically similar. The DVDs contained identical academic content, half with the Smartboard-lectures and the other half the Flash teaching modules. Student performance data from the course was collected through WebCT assessments (quizzes and an exam) in spring 2010, and student learning differences were determined, using a Felder-Soloman Index of Learning Studies framework.

Keywords: Biorenewables, distance education, biomass production, Smartboard lecture, Flash.

Introduction

Technology has been a driver in the advancement of distance education throughout its history, serving citizens with limited access to educational programming. Distance education started in the 1700s in Europe as mail correspondence courses (Jeffries, 2010). It crossed the ocean and took root in the United States, taking off in the late 19th century when women found it a viable education option (Nasseh, 1997). University professors started recording lectures on phonograph records for distribution to students at distant locations in the early 1900s (Wisconsin, 2005). The next step appeared to be radio, but it never took off due to low enrollments (Jeffries, 2010). Television was the next great technology advancement in distance education, with Iowa State University leading the way as the first university station to broadcast educational content (courses?). At its peak in the 1970s, 222 universities operated television stations (Jeffries, 2010). Telecasts reached citizens in remote areas with a lecture-style product similar to that offered in university classrooms. Satellite and fiber-optic network systems followed that allowed a reasonable option for two-way communication between student and instructor (Jeffries, 2010; Wisconsin, 2005). Professors started to use the Internet to supplement face-to-face courses in the 1980s with LISTSERV resources and email (Jeffries, 2010). As bandwidth has increased making high speed access more prevalent, technology has developed to take advantage of the Internet channel. Learning resources are now at a student's fingertips through the Internet.

The U.S. Department of Education's National Center for Education Statistics (NCES) (2008) reported that 66% of two-year and four-year degree granting postsecondary institutions offered at least one distance education course in 2006-07. The rate was higher for four-year public institutions (89%) for all types of continuing education courses, and 88% for college credit courses (USDoe-NCES, 2008). Distance education has room to grow through penetration within four-year higher education institutions. The NCES (2005) reported that only 6% of faculty at public doctoral degree granting institutions had taught a distance education course.

The development of effective delivery methods becomes increasingly important to universities where the number of college-age students is expected to decrease significantly over the next decade. For example, the Minnesota Office of Higher Education expects the number of high school graduates to peak in 2009 and start to decrease (Minnesota, 2006). Iowa has had decreasing K-12 enrollments for over a decade, though projections predict an upturn in enrollments may start in 2011 (Iowa, 2010).

Studies found no significant difference in student learning between face-to-face and distance education environments (Bourne et al., 2005; Chen and Jones, 2007). Bourne et al. (2005) described the advantages and disadvantages of online distance education distribution systems as follow:

Advantages

- Students had success learning online
- Students were satisfied with the online learning experience
- Increased flexibility and convenience for students
- Constructivist approaches worked well online
- Delivery costs were comparable face-to-face delivery
- Courses were more scalable

Disadvantages

- Social connectivity was reduced, if not handled well
- Students may struggle with differences in media
- Instructor time commitment may be greater

Research was needed to identify and develop new methods for distance education to thrive. This project was designed to evaluate two delivery methods used in distance education.

In 2007, a USDA Higher Education Challenge Grant funded the creation of a Virtual Education Center (VEC) for Biorenewable Resources at three partner land-grant institutions. Three new courses were taught through the VEC, each using multiple instructors and exchanges of video lectures between sites. One of the courses offered by the VEC had the ISU designation of BRT 501 – *Fundamentals of Biorenewable Resources and Technology*.

The overarching goal of this project was to compare BRT 501 student performance for two online delivery methods: 1) a standard video lecture with use of a Smartboard and 2) a self-contained Flash teaching module.

The BRT 501 syllabus (Raman, 2010) described the course as an introduction “to the science and engineering of converting biorenewable resources into bioenergy and biobased products.” Topics included the following: defining the resource base; physical and chemical properties of biorenewable resources; descriptions of biobased products; methods of production for biorenewable resources; processing technologies for fuels, chemicals, fibers and energy; environmental impacts; and the economics of biobased products and bioenergy. The primary lecturer for the course was Dr. D. Raj Raman, Associate Professor, Department of Agricultural and Biosystems Engineering and Associate Director of Educational Programs, Bioeconomy Institute at Iowa State. Katrina Christiansen, Graduate Research Assistant and Ph.D. candidate, Department of Agricultural and Biosystems Engineering served as the graduate teaching assistant. Darren Jarboe, Program Manager, Center for Crops Utilization Research and Ph.D. candidate, Industrial and Agricultural Technology served as special lecturer for biomass production module, the course topic during which the data for this study was collected.

BRT 501 biomass production content was delivered to students via one of two methods: video with Smartboard or Flash. Both versions were accessed through the WebCT learning system at Iowa State. Several factors will be evaluated for their impact on student learning using these two methods (Table 1).

Flash was selected due to its widespread availability on multiple computer operating systems. A Millwood Brown (2009) survey conducted in December 2009 for Adobe Corporation estimated that the Flash plug-in was on 99% of computers in mature markets, which included Australia, Canada, France, Germany, Japan, New Zealand, the United Kingdom, and the United States, representing 73% of the world’s Internet users. Other media plug-ins with significant market share were Java (77%), Apple Quicktime Player (61%), Adobe Shockwave Player (52%), and RealOne Player (32%).

Purpose

The overarching purpose of this study was to determine the comparative learning experience from lectures distributed through two methods: video with a Smartboard and Flash. In this study, student learning experience was measured in the online course of Biorenewable Resources and Technology (BRT) 501 at Iowa State University in spring semester 2010. The research objectives for the project are:

1. Identify the demographics and characteristics of students who take BRT 501.
2. Determine if the standard lecture with use of a Smartboard or a self-contained Flash teaching module is more effective for BRT 501 student learning.
3. Identify student characteristics or demographics that impact BRT 501 student learning for both the standard lecture with use of a Smartboard and self-contained Flash teaching module instruction methods.
4. Determine the delivery method modifications that would improve student learning experiences in BRT 501.

Materials and Methods

Site and Participants

The Iowa State BRT 501 course had 47 students enrolled for spring semester, 40 on-campus and seven off-campus. The on-campus students attended class on the Iowa State campus in Ames, Iowa. Students were graduate students or upper level undergraduate students from various majors, many of which were technical in nature (i.e., engineering, agronomy).

Human Subjects

Since live humans were involved, the Institutional Review Board for Human Subjects (IRB) in the Office for Responsible Research at Iowa State reviewed and approved the study. The IRB determined the project was exempt from the requirements of the federal human subject regulations. Dr. Raman, Christiansen, and Jarboe successfully completed the *Protecting Human Research Participants* training offered by the National Institutes of Health Office of Extramural Research as required by the IRB. The participant consent form and student survey were reviewed and approved. Student survey data was gathered using Surveygizmo.com shortly after completion of the biomass production module. The results were gathered and held by Iowa State Engineering Distance Education until grades were posted and then released to the authors.

BRT501, the Course

New online BRT 501 course lecture videos and Flash teaching modules on biomass production were developed. The seven lectures covered production of corn (two lectures), soybean, hay and forages (two lectures), and short rotation woody crops. A final lecture on plant biotechnology rounded out the series.

The following information was covered in the lecture for each crop:

- History
- Land quality and value
- Nomenclature
- Crop rotation
- Classification
- Costs of production
- Composition
- Challenges, advantages, and outlook
- Production operations

The biotechnology lecture covered history, genetic engineering methods, biotechnology in agriculture, and challenges, advantages, and outlook.

The biomass production content was delivered to students via WebCT starting in the ninth week of the semester. The presentations used slides with text, images, and example problems. Financial information on corn, soybean, and hay and forage production used the costs of production from *Estimated Costs of Crop Production in Iowa – 2010* (Duffy, 2009). Short rotation woody crop costs of production were from *Assessing the Economic Feasibility of Short-Rotation Woody Crops in Florida* (Langholtz et al., 2007). All students had access to PDFs of the biomass production PowerPoint presentations. There were also links to supplemental video content on biomass production and biotechnology.

BRT 501 assessments for the entire course as outlined by the syllabus (Raman, 2010) were: projects (20%), quizzes (15%), midterm exam (30%), and comprehensive final exam (35%). The WebCT-based quizzes reinforced student understanding of the course material and prepare them for the midterm and final exams. A categorized discussion board was used to answer questions on lectures and quizzes and for in-depth discussions of course readings. Two projects were assigned to students during the course of the semester. All course assessments were WebCT-based, unproctored, and on the honor system.

The students took five quizzes broken into 15 segments. The quizzes highlighted a few of the major topics from each lecture. There were 13 final exam questions covering biomass production will be given during finals week in May.

Survey, Data Collection, and Analysis

Students were ranked based on their performance on quizzes, projects, and the midterm exam for the first half of BRT 501. Odd numbered students were placed in Group-one and even numbered students were placed in Group-two, dividing the class into two academically equal groups. Group-one received the lecture content in a video with Smartboard format and Group-two received the lecture content in a Flash format. Student learning for the two groups will be evaluated and compared. The academic content of the two methods was virtually identical.

Deleted:

The data collected were a learning style assessment, quiz and exam scores, and student survey.

Zywno (2003) found that students had trouble understanding the questions of the Kolb Learning Styles Index (LSI) and questioned the reliability of results if students did not understand the questions. Sample size would limit the usefulness of the Myers-Briggs Type Index (MBTI) results. The learning styles assessment selected for this study was the Felder-Soloman Index of Learning Styles (ILS). The Felder-Soloman ILS is a blend of the MBTI, Kolb LSI, and other psychometric measurement tools (Felder and Spurlin, 2005). Felder and Spurlin (2005) summarized test-retest studies conducted for the Felder-Soloman ILS. The results showed correlation ranges from 0.5 to 0.9 for research projects at twelve institutions of higher learning. The learning style assessment has the potential to empower students through the knowledge gained about their personal learning style (Felder and Soloman, 2010).

Quizzes covering biomass production were developed and presented to students through WebCT following each lecture. Students completed the quizzes, which had true-false, multiple-choice, and matching questions, and calculation problems. Quizzes were scored by WebCT using a key set up by Christiansen. After the assessments are completed, the quizzes and final exam will be scored and graded within each group and then normalized across the entire class.

A student survey was developed and delivered to gain student demographic information and student perspectives about the content delivery method, course content, student learning, and student-instructor communication. Student demographics influence learning so these were explored to determine their impact on student learning with these two technologies. The student

demographics of interest were: student learning style (standard assessment and self-assessment), student background in biomass production (grew up on a farm and/or majoring in production agriculture), student major and degree program (undergraduate, M.S., Ph.D., or other), on-campus or off-campus student, and traditional or non-traditional student. The remainder of the survey questions focused on knowledge acquisition by students, assessments, student effort, student computer proficiency, comparisons with other modules, student-instructor communication, and the course delivery system.

The survey collected both quantitative and qualitative data. It used a one-shot design, which collected data from students after the module was completed (Russ-Eft and Preskill, 2001). The advantages of this design were simplicity, low cost, data gathered as part of the class, and it provides information for comparison. The disadvantages were no control for other effects and the findings may not be generalized to other populations (Russ-Eft and Preskill, 2001). One survey question used a retrospective design (Russ-Eft and Preskill, 2001) similar to Greder et al. (2010) to collect data about student baseline knowledge of biomass production and knowledge after viewing the biomass production material. To protect students, the survey data were embargoed by Iowa State Engineering Distance Education until after course grades posted in mid-May 2010.

Cost and development data for module development and delivery under both video with Smartboard and Flash were collected.

A single factor analysis will be conducted for the learning experience to determine if the difference between the two delivery methods was statistically significant in the whole population. Table 1 lists the factors that will be analyzed. For each factor measured in this study, a two-way ANOVA (the other factor was delivery method) will be conducted to determine if the learning experience is statistically different for the factor among: 1) the whole sampled population; 2) each sample that received the crop production module through a different delivery method (video or Flash); and 3) the relationship of the two factors. Based on these results, correlation analyses among these factors will be conducted to provide understanding about their relationship to the learning experience.

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The online discussion component of the course will be analyzed for themes based on content delivery method (video vs. Flash), learning styles, and demographic data.

Qualitative aspects of student experiences with the two technology platforms were collected and will be analyzed, providing insight into student learning processes. For example, how students use the course module may better enable a student's preferred method of use.

Other factors in the biomass production module that were explored are: student likes and dislikes about the delivery method used, student perceptions of the biomass production module, self-reported study time, student-instructor communication, and overall educational experience.

Learning style may correlate with student performance on assessments and self-assessed performance in BRT 501. This may show that students with a given learning style have better learning performance with one online delivery method over the other. This information could be used to enhance student learning through course customization or changing/adding content delivery methods.

Supplemental videos of biomass production activities were provided as part of the biomass production module. Students were queried about additional resources, such as the videos, that would make the biomass production module more effective for student learning.

The cost and time required for module development and delivery method were estimated for content delivered through the video with Smartboard and Flash formats. These values will be

compared with the student learning information to determine the economics of the two content delivery methods.

Validity

The sample size of 47 and randomization of the class into two groups of equal academic standing in the class may enable the results to be generalized to a larger population. Results from Zywno (2003) and Felder and Spurlin (2005) showed that the Felder-Soloman ILS has validity and reliability. There will be research bias in the qualitative evaluation of the student survey responses and the discussion board posts. Researchers have followed and will follow scientific approaches to insure qualitative outcomes represent the views expressed by BRT 501 students.

Potential Challenges

There were challenges that impacted the study. Those identified were sample size and randomization, media modalities, and use of the Felder-Soloman ILS.

Sample size and randomization may create difficulties for statistical analysis. The sample size of 47 may be too small to show statistically significant differences. The ranking system used to sort students into two randomized groups based on performance in the first half of the course may not provide good randomization because the previous assessments were on engineering principles and chemistry, not biomass production or financial information.

Student learning differences between the video with Smartboard and Flash presentations may be due to the dual modality medium (visual and audio) of video and single modality medium (visual) of Flash. Debuse et al. (2009) stated that according to Cognitive Learning Theory students had finite capacity to accept information and process it for long-term storage and retrieval. Visual and auditory have been the main channels for student information gathering in distance education. The visual and auditory channels were additive, allowing the video presentation more "bandwidth" if learners were pushed to capacity. Debuse et al. (2009) and Day et al. (2005) found this might not hold true for longer presentations (>1 minute).

Students saw the instructor in the video with Smartboard presentation and not in the Flash presentation. Day et al. (2006) found significant differences in student learning when video presentations were used and the only difference was the instructor's image was visible to students. They speculated that nonverbal information was being passed to students via the instructor's image. The study found a significantly higher level of student learning through video, audio, and PowerPoint slides delivery as compared an audio and PowerPoint slides delivery for an online training course offered to Georgia Institute for Technology students. This same effect could impact student learning performance in this study, favoring the video presentation.

Van Zwanenberg et al. (2000) raised the issues of construct validity and internal reliability of the Felder-Soloman ILS. They had a mixed sample of engineering and business students and had weak test-retest results with the Felder-Soloman ILS. The students in our study were from a variety of majors since biorenewable resources and technology is based on integrated systems.

Results, Discussion, and Conclusion

The Annual Meeting manuscript deadline was over a week before the end of the BRT 501 course. The data is not included in the paper due to its embargo until course completion. The data will be presented at the meeting.

Table 1. Correlations to be explored in this study.

| Factor | Delivery method | Student learning style | Student's agricultural background | Student major | Student degree program | Non-traditional student | Student learning, quizzes | Student learning, self-assessed | Student rating of biomass module |
|-----------------------------------|-----------------|------------------------|-----------------------------------|---------------|------------------------|-------------------------|---------------------------|---------------------------------|----------------------------------|
| Delivery method | | | | | | | | | |
| Student learning style | | | | | | | | | |
| Student's agricultural background | | | | | | | | | |
| Student major | | | | | | | | | |
| Student degree program | | | | | | | | | |
| Non-traditional student | | | | | | | | | |
| Student learning, quizzes | | | | | | | | | |
| Student learning, self-assessed | | | | | | | | | |
| Student rating of biomass module | | | | | | | | | |
| Student self-reported study time | | | | | | | | | |
| Biomass production videos | | | | | | | | | |
| Student computer proficiency | | | | | | | | | |
| Student location | | | | | | | | | |
| Overall educational experience | | | | | | | | | |
| Module development cost | | | | | | | | | |

Table 1. Correlations to be explored in this study ^(cont'd).

| Factor | Student self-reported study time | Biomass production videos | Student computer proficiency | Student location | Overall educational experience | Module development cost |
|-----------------------------------|----------------------------------|---------------------------|------------------------------|------------------|--------------------------------|-------------------------|
| Delivery method | | | | | | |
| Student learning style | | | | | | |
| Student's agricultural background | | | | | | |
| Student major | | | | | | |
| Student degree program | | | | | | |
| Non-traditional student | | | | | | |
| Student learning, quizzes | | | | | | |
| Student learning, self-assessed | | | | | | |
| Student rating of biomass module | | | | | | |
| Student self-reported study time | | | | | | |
| Biomass production videos | | | | | | |
| Student computer proficiency | | | | | | |
| Student location | | | | | | |
| Overall educational experience | | | | | | |
| Module development cost | | | | | | |

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