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Virtual Education Center for Biorenewable Resources: Humanizing Distance Education

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Keywords
Distance education, improvements, social learning, biorenewable resources

Disciplines
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Comments
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Abstract

Despite the obstacles to traditional distance education courses, distance education and social learning theorists suggest effective distance education courses can be developed. For this study, we designed a new distance education course model and attempted to 1) Test the effectiveness of the virtual education center model, understood through the lens of social learning and distance education theories; 2) Discuss potential improvements to the model; and 3) Build upon distance education and social learning theories. To achieve these goals, distance education courses were offered using the new model. Participating faculty and graduate assistants responded to a survey asking about their experiences with the model. Undergraduate learning was assessed by examining students' quiz grades, the number of times they attempted quizzes and their ratings and comments for each class period. Students demonstrated learning regardless of whether lectures were live or recorded. Faculty members and graduate assistants learned about biorenewable resources and offering courses through distance education; they also made suggestions to improve future distance education courses. The distance education model used in this study is an effective means of educating students, teaching assistants, and faculty members. Implications for distance education theory and distance education efforts are discussed.

Introduction

As biorenewable resources have become increasingly important nationwide (Biomass, 2002; Biobased, 2003; Van Gerpen, 2005; Brown, 2003; Kamm and Kamm, 2004), universities have struggled to provide students with the up-to-date education required to train graduates for critical roles in industries producing and using biorenewable resources. Faculty experts on renewable resources, while nationally plentiful, are spread diffusely throughout the country; no single institution has experts in each area of biobased products and technologies. Moreover, although student interest across the nation in this area is significant, student numbers at any single institution are often insufficient to meet minimum enrollment requirements for relevant courses. If students could be shared across institutions, a critical mass of students from multiple institutions could populate a single course. If faculty at each institution could provide lectures for the course, then the overall teaching load for each faculty member would decrease. Taken together, such an approach could simultaneously increase the quality of lectures provided to students and increase the efficiency (student credit hours per unit faculty effort) of instruction. Distance education provides an opportunity for such a model.

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The effectiveness of distance education is well proven (Gomory, 2001; Mayadas, 2001; Peterson and Feisel, 2002; Merino and Abel, 2003; Coward et al., 2000). Distance education can help establish and maintain critical academic fields, despite geographic dispersal of faculty and students. However, distance education runs the risk of reducing student connectivity, can pose technical problems, and may require an increased time commitment for instructors (Bourne et al., 2005). Providing effective distance education can be even more complex for technical fields such as science, agriculture, and engineering (Campbell et al., 2002; Campbell et al., 2003). Most faculty members prefer teaching courses face-to-face and perceive increased opportunities for student interaction in non-distance courses (Taylor and White, 1991).

Synchronous distance education learning allows for student-instructor interaction, but these interactions are seldom at the same level as can be achieved by direct classroom interaction between the instructor and students. In fact, researchers have found that many synchronous distance education environments lack interactivity; students are often unable to ask questions or receive direct feedback, and both teachers and students tend to interact less, even when interaction is an option, due to the cumbersome technical processes involved (Angeli et al., 2003; Mauve et al., 2001). Overall, the achievement rates of students in traditional classroom settings tend to surpass those of their counterparts in synchronous learning environments (Bernard et al., 2004).

The barriers to multi-institutional distance education efforts are well known to practitioners but poorly documented, although some have noted prohibitive costs, difficulties with technological limitations, timing of courses around holiday breaks and across time zones, unequal student prerequisites at the different institutions, and problems achieving interaction with both on-site and off-site students (Crow et al., 2000; Muilenburg and Berge, 2005).

Distance Education Theory

Some scholars have become disillusioned with distance education, citing the many problems that create barriers to effective distance education and even calling it a "pursuit of fool's gold" and a "technological tapeworm" (Noble, 1999; Noble, 2001). Others remain more optimistic, pointing to the theory that has begun to emerge from distance education research as evidence that distance education can become more effective if distance education theory is allowed to grow and change as technology and research progress (Garrison, 2000; Gunawardena and McIsaac, 2004). These scholars emphasize using the existing body of research to design effective distance education courses.

Distance education theory is a constructivist approach, and theorists stress multiple factors as being important in distance education courses (Garrison, 2000; Gunawardena and McIsaac, 2004): 1) Delivery and accessibility of course content; 2) Control (e.g., whether students can watch lectures anytime and can stop and rewind them versus having lectures which students must watch at a given time); 3) The amount of teacher-student interaction and student-student interaction (Garrison and Cleveland-Innes, 2005; McIsaac and Gunawardena, 1996; Moore, 1989); 4) The amount of social presence created by the method of course delivery (the extent to which students feel like a part of the class); 5) The amount of transactional distance (the amount of structure in the course and the amount of teacher-student dialog) (Moore, 1990); and 6) The characteristics of the medium used to transmit information from teacher-student. The ideal class, these theorists argue, would thus employ methods of teaching and use a medium that would allow high levels of accessibility to course content, student control, interaction, social presence, and low levels of transactional distance.

Social Learning Theory and Distance Education

Social learning theory, like distance education theory, is a constructivist approach that lends insight into the factors which shape effective education. Social learning theory has been applied to distance education in ways that sometimes overlap distance education theory and often expand it. Social learning theorists state that the first important point of designing a distance education course is paying attention to the context (Hill et al., 2009). As part of this, these theorists stress that learning takes place in real-world environments (Jonassen et al., 1995; Norman, 1993; Woo and Reeves, 2007), during quality interactions, (Garrison and Cleveland-Innes, 2005; Henning, 2004; Woo and Reeves, 2007) and via modeling (Bandura, 1977). Because interaction is important, theorists say it is important to monitor class sizes for online courses to increase interaction (Palloff and Prat, 1999) and provide and use a variety of mediums to accommodate different learning styles (Hill et al., 2009). Social learning theorists also pay attention to the culture in the online classroom, since researchers have found that students' gender and ethnicity impact classroom experiences (Fahy, 2002; Lim, 2004; Wheeler, 2002). Social learning theorists emphasize community in the classroom. Similar to social presence, this refers to the sense of belonging in the class (Hill, 2002). Finally, social learning theorists recommend paying attention to the learner characteristics of students in the classroom and their epistemological beliefs, learning styles, level of self-efficacy (Bandura, 1993), and their motivation for the course (Hill et al., 2009).

The Virtual Education Center Model

To overcome the problems common to distance education, we hypothesized that an effective inter-institutional model could be developed using the theoretical guidelines proposed by distance education theory. It was hoped that the development of such a model could educate students in biorenewable resources and thus have implications at the state, regional, and national levels. To create an effective distance education model, faculty from three land-grant institutions collaborated to teach three inter-institutional biobased courses: Fundamentals of Biobased Products and Technologies, Production and Use of Biofuels, and Thermochemical Processing of Biomass. This resulted in the development of a new course model (Figure 1), with similarity to distance learning and social learning theories, called a virtual education center (VEC).

In the VEC, faculty from multiple institutions share video lectures with one another, and each faculty member uses their own lectures, and video lectures from off-site instructors, to teach students at their own institution.

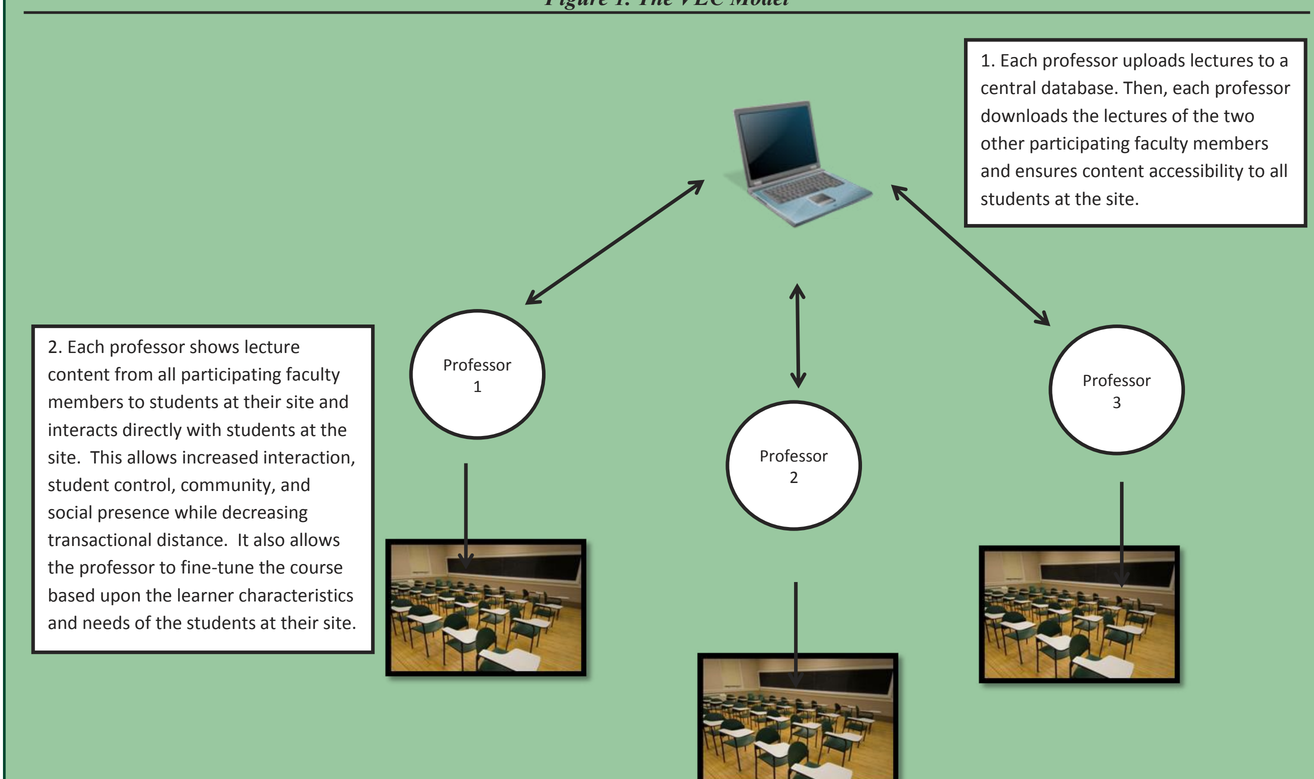
The goal of this study was to 1) Develop an effective distance education model that can overcome the obstacles of faculty and student dispersal; 2) Test the effectiveness of the new distance education model, understood using the lens of social learning and distance education theories, in promoting undergraduate, graduate, and faculty learning; 3) Discuss potential improvements to the developed course model; and 4) Build upon distance education and social learning theories based upon the results of this study.

Approval for this study was granted by the Institutional Review Board at the university where the study took place.

Method

For this study three faculty members worked together to deliver a total of 42 lectures. All lectures were recorded and made available to all instructors electronically; each instructor was responsible for making the recorded lectures available to students at their own site (that is, there is no central site where all students go to see the lectures). This is significant because 1) faculty members did not wish to be responsible for IT support to students at other institutions, and 2) it ensures the accessibility of the content for students. When using lectures from collaborating faculty members, the on-site instructors

Figure 1. The VEC Model



typically had students watch the lectures outside of class and then used recitation-style class meetings to review key concepts or work problems.

In delivering the recorded lectures, multi-modal files with two panes were used so that a small image of the instructor and a larger image of an electronic whiteboard or PowerPoint slide could be displayed to the students. Each course was offered for credit by each of the participating institutions. Teaching resources were shared; however, no credits or fees were exchanged between universities.

The VEC model was an effort to share geographically diverse resources – while maintaining the best aspects of in-class lectures – and allowing students to learn by observing their instructors experience and solving hands-on, logical, or quantitative problems and allowing passionate instructors to bring subjects to life. Typical distance education models have suffered from a lack of faculty-student interaction and student-student interaction. In this model, however, students still learned within a classroom, meaning that levels of interaction, along with feelings of social presence and community, were increased while transactional distance was decreased.

In the following sections, the effectiveness of this model in reaching the goals of promoting student, graduate assistant, and faculty learning is explored. Ways in which the model could be improved are suggested, and implications for distance learning and social learning theories are discussed.

Faculty and Graduate Assistant Survey

The first VEC for Biorenewable Resources course was taught during the spring semester of 2008. By the fall semester of 2009, 14 collaborative, inter-institutional VEC classes had been taught among three participating institutions. At the end of the fall 2009 semester, a web survey was e-mailed to the nine participating faculty members and graduate assistants across the three contributing institutions. The survey was constructed to assess what the faculty and graduate assistants may have learned or gained from their experience working with VEC model, and what could be improved in future VEC and distance education courses. The survey consisted of five multiple-choice questions and nine open-ended questions that assessed each respondent's role and experiences with the course. Four of the five multiple-choice questions also had space for comments. Survey data were analyzed for frequencies and means, and comments were coded by theme.

Undergraduate Student Responses, Quiz Data, and Grades

To assess the impact of the VEC model on undergraduate students, the 33 students enrolled in the largest Fundamentals of Biorenewables course were asked to rate the video segments and provide comments. Student performance on quizzes was also used to help assess the impact of each segment on student learning. Two- to four-question quizzes were developed for each segment by the faculty member at the university where the study took place. Data were collected for each of the 89 segment quizzes that students completed for two reasons – 1) It made it possible to compare student learning and rating of recorded versus live lectures and 2) Some researchers have pointed out that distance education research has struggled to provide information about student learning and experiences throughout the course, instead of using only final grades and outcomes assessments (Gunawardena and McIsaac, 2004). Data collection included students' open-ended responses regarding each segment, the grades students received on each quiz, the number of attempts students took to complete the quiz, and a student rating of the segment.

Following a segment quiz, students were asked to rate the segment, giving it a letter grade of "A", "B", "C", "D", or "F". Student ratings of segments were recoded into numerical values based on a typical GPA scale. Segment ratings could range from A (4.0) to F (0.0). Student ratings were averaged for each segment, and segments were ranked by their mean rating. Quiz grades were converted to percentages. Student comments for each segment were organized by whether the segment was live or recorded, and analyzed using word search functions and identifying common codes and themes.

Results

Promoting Faculty Development

The nine faculty members who participated in course instruction agreed that faculty learning and faculty development had taken place. On average, the faculty members responded that expectations for documenting learning of current faculty members and graduate teaching assistants was "mostly met." One faculty member reported that "current faculty learned quite much in the process." Another reported learning how to use graduate assistants more effectively; others commented they had expanded their knowledge on technology usage. One faculty member remarked, "Class discussions helped me organize my own thoughts on emerging topics in the field," which helped her pursue her research more effectively. In addition, five faculty members indicated participating with the VEC enabled them to recruit new graduates students, two leveraged new funds, two presented papers at a professional conference, and one had an article in progress. Six faculty reported expanding the content of their courses and were able to employ new teaching methods in the classroom. Finally, collaboration was increased among faculty both intra- and inter-university. Faculty members responded that they were collaborating, on average, “very effectively” with their colleagues at their institution, and “effectively” with colleagues at the other institutions for the purposes of the VEC.

Promoting Graduate Assistant Learning

Three graduate teaching assistants who responded to the survey reported serving as teaching assistants for at least one VEC course for Biorenewable Resources. The remaining graduate assistant reported that her role had focused on course development and revision. In open-ended responses, graduate assistants elaborated on these roles. At least two graduate students reported being responsible for each the following: quiz preparation, flagging questions, requesting video uploads, and grading. One graduate assistant reported the additional responsibility of developing and presenting two lectures.

One graduate assistant and five faculty members reported the VEC course enhanced graduate student recruitment. Through their experiences with the VEC courses, two graduate assistants collaborated with the faculty and/or graduate students outside their home institution, and all four increased collaboration with faculty at their home institution. Further, four graduate assistants were involved with the development, delivery, and evaluation of the course, and they indicated that their participation was effective in regard to these elements. Three graduate assistants reported using new teaching methods, one expanded the use of content in the course, and one student and six faculty responded that participating in the VEC had enhanced career opportunities for doctoral candidates. Graduate students expressed appreciation for being given opportunities to develop and deliver education materials, provide lecture topics and objectives, observe the amount of work and aspects that are required for developing a new course, apply previous knowledge, and interact with faculty. Overall, graduate assistants reported learning about biorenewables and teaching through their experience with the VEC.

Promoting Undergraduate Learning

After completing each course segment, students were asked to comment on the segment. Students commented on all 89 course segments, with an average of 8.66 students commenting per segment and a total of 771 comments throughout the semester. Overall, student comments tended to be vague. Eight of the 33 students in the class made comments for nearly every segment, and these students tended to give the same responses throughout the semester. Especially when making positive comments, students tended to provide very few examples. The comment “Good”, for example, was made a total of 302 times, occasionally interspersed with comments such as “Very Good,” (8 times) or “Ok,” (45 times). Negative comments were usually followed with more specific examples. Negative comments were often related to problems students experienced with the quiz, but some negative comments did apply to the segment overall. As the semester progressed, students commented less often and comments became increasingly short and imprecise (one-word responses were often given). Because the one-word responses were prevalent, vague, given by the same students repeatedly, and stable throughout the semester regardless of the segment or whether the segment was live or recorded, these comments failed to lend insight into the effectiveness of the VEC model. Therefore, they were excluded from further examination. However, noting that “Good” was the most common comment regardless of segment or whether the lecture was live or recorded is important because it provides insight in recognizing that while some students may have struggled with certain segments, several students likely commented that the segment was “Good” and most of the class seemed not to care enough to take the time to comment at all.

The recorded lectures were complimented as being easy to understand, having good overviews, and having good examples. Conversely, students noted that it was occasionally difficult to stay focused on the lectures as they sometimes perceived them to be dry, choppy, lacking in contextual explanations, going “too fast,” or jumping from one topic to the next. Students also noted that many of the quiz questions did not seem to correspond to the lecture material.

In regard to the live lectures, students liked the overviews and discussions. One student commented that the lectures all made sense. Conversely, another student perceived one segment as tough to follow. Several students found that lecture material was covered too quickly to write notes.

For both live and recorded lectures, students commonly expressed concern about the quizzes.

Many students noted confusion about abbreviations used in the quizzes. Technical glitches with quizzes also caused problems for students; and students voiced disagreement with the quizzes 16 times, pointing out spelling errors and questioning the answer keys for some quizzes. Students indicated quizzes became more user-friendly as the semester progressed, suggesting faculty and students became more familiar with the technology.

Undergraduate Segment Quiz Attempts, Grades, and Ratings

Overall segment rating averages ranged from 3.35 to 3.81, and the mean rating across segments was 3.65. Mean segment ratings, quiz attempts, and quiz grades are summarized in Table 1. Live lectures were rated significantly higher than were recorded lectures ($t = 3.47$, $p<.001$), though the practical difference between the two styles was minimal: live lectures received an average rating of 3.68, compared 3.62 for recorded lectures. There were no significant differences between live and recorded lectures in regard to quiz grades or the number of quiz attempts.

Table 1. Quiz Attempts, Quiz Grades, and Segment Ratings for Live and Recorded Lectures

	Quiz Attempts (n)		Quiz Grades (%)		Segment Ratings (0-4)	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Live Lectures	1.59	0.30	93.85	3.66	3.68	0.09
Recorded Lectures	1.6	0.34	93.58	4.38	3.62	0.06

$t = 3.47$, $p<.001$

Improving the VEC

Faculty had suggestions for improving the content of the VEC course in relation to the course content, lecture partners, and opportunities for graduate assistants (Table 2).

Sixteen faculty comments related to improving the content of the VEC course. Two faculty suggested assigning the recorded lectures as homework instead of viewing them during class time. Four instructors suggested questions be developed about the lecture content and discussed during class time. Further, two instructors wanted more documentation of student learning. Four suggested that student ability varied greatly, and the lecture content was too easy for certain students and too hard for others. These faculty members noted that it would be beneficial to have tighter prerequisites and gear each class toward students with appropriate background knowledge and/or to have homework assignments that can meet the needs of students at varying levels of understanding of the course material.

Thirty-three faculty suggestions related to improving how lecture partners work together. Four faculty mentioned the importance of choosing faculty who could work well together; the importance of making sure that all participating faculty members had the necessary technology capabilities and IT supports services was mentioned seven times while six faculty commented on the importance of choosing faculty who were committed to devote their time to the VEC course. Eight of the nine faculty wanted collaboration between lecture partners to be increased; these faculty members said that it would be useful to have the lecturers from the different institutions work together on coordinating the focus of the courses.

Six faculty comments related to improving opportunities for graduate students. Three faculty members wrote that graduate assistants should have increased teaching responsibilities in future VEC courses to increase graduate assistant learning, facilitate inter-university collaboration and lessen faculty workload. Additionally, faculty pointed out that allowing them to teach would provide graduate assistants greater networking opportunities and increase the range of the VEC courses once these graduate students began obtaining faculty positions of their own. Further, faculty noted that graduate assistants have valuable ideas that could help guide the direction of the courses.

Discussion

The VEC model was an effort to share geographically diverse resources – while maintaining the best aspects of in-class lectures – allowing students to learn by observing their instructors experience and solve problems, and allowing passionate instructors to bring subjects to life. The VEC enabled instructors to fine tune the course to the unique needs,

Table 2. Faculty Suggestions for Improving the VEC

Faculty Suggestions	**n**
Course Content:	16
-Assign lectures for out of class viewing	2
-Develop questions for in-class discussion	4
-Document student course performance	2
-Utilize tighter prerequisites	4
-Ensure class level and homework is appropriate for all students	4
Lecture Partners:	33
-Be purposeful in selecting lecture partners who will work well together	4
-Ensure partners have necessary technological capabilities	7
-Choose partners who are committed to teaching the course	6
-Partners should work to increase collaboration	8
-Partners should coordinate course focus	8
Opportunities for Graduate Assistants:	6
-Allow graduate students to lead some of the course instruction	3
-Utilize graduate students for facilitating inter-university collaboration	3

learner characteristics, and cultural backgrounds of the students at each site. It also allowed students to have increased control over their own learning by providing them with opportunities to ask questions inside and outside of the classroom and to interact with faculty members in person. Levels of interaction with instructors and other students were increased from the traditional distance education course since students still learned within a classroom; thus, feelings of social presence and community were increased and transactional distance was decreased, despite the fact that students were not able to directly interact with the faculty members lecturing from other institutions.

Promoting Faculty, Graduate Assistant, and Undergraduate Learning

Overall, the data show that the model developed was effective at promoting faculty, graduate assistant, and undergraduate learning: students enrolled in the course learned about biorenewable resources and documented this learning in segment quizzes and overall exams, while graduate students and faculty reported learning about biorenewable resources and delivering biorenewables courses efficiently using e-teaching tools.

Faculty not only experienced increased research activity, increased collaboration, and increased knowledge, but they also learned much about the VEC and potential options for improving future VEC courses. Faculty suggested some changes to course content and made important considerations for inter-university collaboration. Their experiences can be helpful not only for the participating faculty members but also could be useful in the future for faculty members intending to take on similar multi-university courses to compensate for the difficulties of traditional distance education courses.

Graduate teaching assistants gained valuable experience while participating in the VEC. The experiences and knowledge gained from this program will likely be useful for them as they finish their degrees, gain faculty positions of their own, and begin teaching courses – especially courses related to fields where faculty tend to be sparsely spread across the country. They gained experience developing and delivering courses, preparing quizzes, grading coursework, and collaborating with faculty both within the university and at the other participating institutions. Faculty acknowledged the importance of these experiences and suggested that graduate assistant learning could be increased if graduate students were given more opportunities for teaching.

Undergraduate students responded favorably to every segment of the course (the lowest average segment rating was above a B and the most common comment for each segment was "good"), although not all segments were rated equally. The number of quiz attempts students made was relatively stable and the quiz grades were high regardless of whether the lecture was live or recorded. This indicates that the distance portions of the course were just as effective at promoting student learning as were the portions of the course that were taught to them through direct, face-to-face interaction. The VEC model of having on-site instructors leading students at each site, then, appears to be an effective means of promoting student learning and overcoming the barriers common to distance education.

Improving the VEC and Theoretical Implications

Examining the responses and comments made by faculty, graduate assistants, and undergraduate students involved with the course provides insight into the VEC model so that suggestions for improving future VEC courses can be discussed. Faculty suggested that it would be useful to assign the online lectures for viewing outside of the classroom, have students bring questions to discuss during recitation-style class meetings, document student performance in the course, and utilize tighter prerequisites to ensure that the class level is appropriate for every student. Also, faculty suggested being very purposeful in selecting lecture partners and partners from other institutions so that all partners have the necessary technological capacities to upload and download lectures, and so all partners are equally committed to developing quality lecture content for the students at each institution. Finally, opportunities for graduate assistants could be increased if graduate assistants were allowed to instruct portions of the course and assist with inter-university collaborations.

Learner characteristics, which are noted in social learning theory (Hill et al., 2009), were brought up as an issue in the case of the VEC, but this emerged as a somewhat different issue from what might be the case in a traditional distance education class. Generally, learner characteristics refer to differences from student to student which might affect the way they learn and perform in the class. In the case of the VEC, instructors could interact with each student as needed and compensate for small student-student differences. However, faculty comments indicated that inter-institutional differences sometimes made it difficult to gear the class toward the diverse makeup of students:

prerequisite courses were part of the challenge, since prerequisite courses and requirements varied across institutions. Thus, in future VEC-style courses, instructors should discuss the variety of students they expect to see in the course and where they expect their students' current levels of knowledge to be. Distance education theorists emphasize paying attention to the delivery methods and accessibility of course content (Gunawardena and McIsaac, 2004), but the focus of this point is usually on the students who would access the content. In the case of the VEC, we assumed there would be no issue with accessibility, since students would not have to access the content themselves. However, problems arose with accessibility and having a common format, but primarily for the participating faculty members rather than for the students. Future VEC courses, then, might be improved by ensuring accessibility – for both students and faculty – before the course begins, and distance education theorists should note that in some models, such as the VEC, accessibility is more of an issue for faculty than students.

Distance education theorists stress striving to increase interaction and social presence (Gunawardena and McIsaac, 2004), while social learning theorists stress interaction and building a sense of community in distance education classrooms (Hill et al., 2009). In the case of the VEC, students and instructors at each site interact directly with one another; in fact, no students indicated a lack of interaction with other students or their professor was problematic, and no faculty members noted lacking interaction with their students, which is often noted in distance education studies (Taylor and White, 1991). The challenge, however, came in at the faculty level – faculty were interacting sufficiently with the students at their site, but interactions with other VEC faculty were limited. Faculty commented that increased collaboration with their partners at other institutions would improve future VEC courses. Distance education and social learning theorists might note that, when multiple faculty members are involved, interaction between them may be important, just as it is for students.

Recommendations for Future Research

For any distance education model to thrive, it must grow and change as technology and learning theory progress. Improving the VEC to further reduce transaction costs – perhaps by closer specification of technologies used and student background expectations – examining more advanced delivery formats, and comparing the teaching efficacy and costs of the VEC to other distance education modes are areas for future research.

Literature Cited

Angeli, C., N. Valanides and C.J. Bonk. 2003. Communicating in a web-based conferencing system: The quality of computer-mediated interaction. British Jour. of Educational Technology 34(1):31−43.

Bandura, A. 1977. Social learning theory. New York: General Learning Press.

Bandura, A. 1993. Perceived self-efficacy in cognitive development and functioning. Educational Psychologist 28(2):117-148.

Bernard, R.M., P.C. Abrami, Y. Lou, E. Borokhovski, A. Wade, L. Wozney and B. Huang. 2004. How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. Rev. of Educational Research 74(3):379-439.

Biobased products and bioenergy vision and roadmap for Iowa. 2003. ISU Extension/CIRAS: www.ciras.iastate.edu/publications/IABioVisionRoadmap.pdf

Biomass Research and Development Technical Advisory Committee, United States Dept. of Energy and United States Dept. of Agriculture. 2002. Roadmap for Biomass Technologies in the United States.

Bourne, J.R., D.A. Harris and A.F. Mayadas, 2005. Online engineering education: Learning anywhere, anytime. Jour. of Engineering Education 94(1):131–146.

Brown, R.C. 2003. Biorenewable resources: Engineering new products from agriculture. Iowa State Press, Ames, IA.

Campbell, J.O., J.R. Bourne, P.J. Mosterman, M. Nahvi, R. Rassai, A.J. Brodersen and M. Dawant. 2003. Cost-effective distributed learning with electronics lab. Jour. of Asynchronous Learning Networks 8(3):5-10.

Campbell, J.O., J.R. Bourne, P. Mosterman and A.J. Brodersen. 2002. The effectiveness of learning simulations for electronics laboratories. Jour. of Engineering Education 91(1):81-87.

Coward, H.R., C.P. Ailes and R. Bardon. 2000. Progress of the Engineering Education. www.nsf.gov/pubs/2000/nsf00116/nsf00116.txt.

Crow, M.L., A. Pahwa, S.K. Starrett, K.J. Olciniczak and S.D. Sudhoff. 2000. Collaborative distance education in power engineering. Transactions on Power Systems 15(1):3-8.

Fahy, P.J. 2002. Use of linguistic qualifiers and intensifiers in a computer conference. The American Jour. of Distance Education 19(3):133-148.

Garrison, D.R. 2000. Theoretical challenges for distance education in the 21st century: A shift from structural to transactional issues. International Rev. of Research in Open and Distance Learning 1(1):1-17.

Garrison, D.R. and M. Cleveland-Innes. 2005. Facilitating cognitive presence in online learning: Interaction is not enough. The American Jour. of Distance Education 19(3):133-148.

Gomory, R.E. 2001. Sheffield Lecture – Yale Univ., January 11, 2001. Internet Learning: Is it real and what does it mean for universities? Jour. of Asynchronous Learning Networks 5(1):193-196.

Gunawardena, C.N. and M.S. Mclsaac. 2004. Distance education. In D.H. Jonassen, ed. Handbook of research for educational communications and technology (2nd ed.):355–395. Bloomington, IN: Association for Educational Communications & Technology.

Henning, W. 2004. Everyday cognition and situated learning. In D.H. Jonassen, ed. Handbook of research for educational communications and technology (2nd ed.): 43-168. Mahway: NJ: Erlbaum.

Hill, J.R. 2002. Strategies and techniques for community building in web-based learning environments. Jour. of Computing in Higher Education 14(1):67-86.

Hill, J.R., L. Song and R.E. West. 2009. Social learning theory and web-based learning environments: A review of research and discussion of implications. American Jour. of Distance Education 23(2):88-103.

Jonassen, D., M. Davidson, M. Collins, J. Campbell and B.B. Haag. 1995. Constructivism and computer-mediated communication in distance education. American Jour. of Distance Education 9(2):7-26.

Kamm, B. and M. Kamm. 2004. Biorefinery – systems. Chemical and Biochemical Engineering Quarterly 18(1):1-6.

Lim, D.H. 2004. Cross cultural differences in online learning motivation. Educational Media International 41(2):163-173.

Mayadas, A.F. 2001. Testimony to the Kerry commission on web-based education. Jour. of Asynchronous Learning Networks 5(1):134-138.

McIsaac, M.S. and C.N. Gunawardena. 1996. Distance Education. In D.H. Jonassen, ed. Handbook of research for educational communications and technology: A project of the Association for Educational Communications and Technology. 403-437. New York: Simon & Schuster Macmillan.

Merino, D. and K. Abel. 2003. Evaluating the effectiveness of computer tutorials versus traditional lecturing in accounting topics. Jour. of Engineering Education 92(2):189-194.

Mauve, M., N. Scheele and W. Geyer. 2001. Enhancing synchronous distance education with pervasive devices. Informatik 2: 1117-1122.

Moore, M.G. (Ed). 1990. Contemporary issues in American distance education. Oxford: Pergamon Press.

Moore, M.G. 1989. Three types of interaction. American Jour. of Distance Education 3: 1-7.

Muilenburg, L.Y. and Z.L. Berge. 2005. Student barriers to online learning: A factor analytic study. Distance Education 26(1):29-48.

Noble, D.F. (1999). Rehearsal for the revolution: Digital diploma mills, Part IV. http://communication.ucsd.edu/dl/ddm4.html.

Noble, D.F. (2001). Fool's gold: Digital diploma mills, Part V. http://communication.ucsd.edu/dl/ddm5.html.

Norman, D. 1993. Things that make us smart. New York: Addison Wesley.

Palloff, R. and K. Pratt. (1999). Building learning communities in cyberspace. Noboken, NJ: Jossey-Bass.

Peterson, G.D. and L.D. Feisel. 2002. E-learning: The challenge for engineering education. Proc. E-technologies in engineering education, a united engineering foundation conference. Davos, Switzerland. http://services.bepress.com/eci/etechologies/, 164-169.

Taylor, J.C. and V.J. White. 1991. Faculty attitudes toward teaching in the distance education mode: An exploratory investigation. Research in distance education 3(3):7-11.

Van Gerpen, J. 2005. Biodiesel processing and production. Fuel Processing Technology 86:1097-1107.

Wheeler, S. 2002. Student perceptions of learning support in distance education. Quarterly Rev. of Distance Education 3(4):5-22.

Woo, Y. and T.C. Reeves. 2007. Meaningful interaction in web-based learning: A social constructivist interpretation. The Internet and Higher Education 10:15-25.