Technology to the Rescue!
Lessons learned from the forced on-line streaming of Dynamics class

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Abstract

Fall semester 2008, an upper division undergraduate Dynamics class was streamed via Elluminate*Live*! to students on the main campus from a physically distant instructor. The course had been developed for lecture delivery through interactive broadcast television between equipped studio classrooms. This class was part of a study into the effectiveness of the broadcast environment for content delivery of undergraduate engineering courses. When the generating studio classroom was vandalized by external intruders, the lectures were ported to live interactive streaming video to personal computers. This paper will discuss both student outcomes and instructor lessons learned from that semester including comparison of results for Dynamics Concepts Inventories with other semesters, Blackboard usage during the semester, anecdotes from students, and observations from the instructor. Information from other instances of interactive streaming of coursework will be compared with the Dynamics class. Questions on appropriate application of streaming technology to undergraduate engineering curriculum delivery are raised.

The student population for the Dynamics class fall semester 2008 was NOT self-selected. Students were not informed before the first day of instruction that the course was to be broadcast and generated off campus. 30% of students answering a questionnaire at the end of the semester STRONGLY agreed with the statement: "Having class sessions on Elluminate was helpful to me". The DCI results showed moderate correlation with grades achieved in the class. However, the results for this semester were not significantly different from those for other broadcast semesters. Students accessed the site most frequently on Saturdays. The instructor found the Elluminate*Live*! sufficiently capable and comfortable to use it exclusively for a graduate class the following semester. That streaming video technology is readily available, sufficiently capable for content delivery and interaction, and some students find it helpful, raises questions about how to most productively exploit this technology for curriculum delivery.

Motivation

The motivation for porting lectures in a junior year Dynamics class to live interactive streaming technology was neither curiosity, buckling to administrative pressure, serving the needs of a grant, nor altruism for commuting and overloaded students. Desperation motivated streaming the class. Two weeks in to a new semester, just when students were becoming accustomed to the interactive broadcast environment normally used for this class, the studio classroom was vandalized and the ability to broadcast lectures compromised. The time estimate for repair of the broadcast room was about two weeks. (Actual restoration of capability took more than a month.)

Contingency plans existed for the loss of communication between sites, but not for extended periods without the ability to record lecture. So, a method to deliver content, temporarily, to students 250 miles apart in a fair and thorough manner needed to be developed between 8 am Monday, when the vandalism was discovered, and 11 am Tuesday when the class next met. Options for content delivery included using a correspondence model, having another faculty member at the main campus teach the remote section, and moving lectures to a portable video teleconference system. Having students study from the book on their own and complete homework and quizzes by correspondence was not an attractive option for this critical junior-level class. No other instructors were readily available to teach Dynamics on short notice for an unknown length of time without overloading their schedules. The portable video teleconference system, while capable of broadcasting lecture, was limited in its ability to broadcast content, like notes, and required reconfiguration for use in the classroom. A more attractive option appeared to be streaming lecture through the course Blackboard site real-time using Elluminate*Live!*. Elluminate has the capability to stream audio, video, and content simultaneously and in real-time to student computers. Students can interact with the content, the instructor, and each other by typing, mousing, or talking, depending on their system capabilities.

What was intended as a stop-gap measure to temporarily avoid a disruption in content delivery for a dynamics class continued through the entire semester because questionnaire results after several weeks of streamed delivery showed that more than half of the students in the class wanted the Elluminate sessions to continue even after broadcast capability in the studio classroom was restored.

The motivation for writing this paper is three-fold. First, after streaming the dynamics class out of necessity, I discovered I liked it and preferred it to broadcast. Study and introspection is continuing to determine why streaming was preferable to broadcast. Second, recognizing this preference, and noting that about a third of the students also share this preference, questions arise that must be answered to determine the appropriate role for streaming content in a standard Engineering curriculum. Third is a recognition that fundamental assumptions made in previous research are in error. That research effort needed to be concluded and a new hypothesis developed based on a student-centered content delivery.

Original Course Structure and Educational Research Hypothesis

The Fall 2008 section of Dynamics class was planned as an interactive broadcast class and was part of a study into the efficacy of the interactive broadcast method for generating learning outcomes in junior-level engineering courses[1]. The class is generated at the remote location to transfer students primarily from one community college pursuing a mechanical engineering degree objective through the main campus University. The distant students are on the main campus and are a mix of civil and mechanical engineering degree objective students from the distribution of students native to the main campus with a small percentage, usually less than 10%, of transfer students from main campus local community colleges. A control group of direct-contact method instruction main campus students that is not broadcast is not possible since this instructor does not teach in residence on the main campus. Similarly, the remote program does not have sufficient students to permit a second section to be taught without broadcast. So,

this case exists in isolation from a control group and generalizations must be considered very carefully. Generalizations about the technological intermediary effects on transfer versus native student populations can not be made due to lack of a control group of transfer students on the main campus. And, generalizations between civil and mechanical engineering majors cannot be made due to a lack of civil engineering students in the direct-contact group.

The course was delivered in a traditional lecture style with only minor modifications granted for the technology. Modifications made in previous semesters include posting course notes and previous exams to the Blackboard site for the class, using the Dynamics Concepts Inventory (DCI) as a pre- and post-course assessment, deploying a math and calculus quiz in the beginning of the semester to intercept poorly prepared students, inclusion of more demonstrations in class, and use of some conceptual test questions that do not require calculations.

Fall 2008 was the first semester to use three full class period mid-term examinations for assessment along with a two hour comprehensive final examination. Previous semesters employed a quiz-per-week for assessment of course content assimilation along with a comprehensive final. The change from the quiz-per-week format was part of a larger strategy to change delivery styles from instructor-centered to student-centered, as part of the continuing improvement of the broadcast pedagogy. Also, the longer time period and multiple questions used in a full class period exam allowed for the addition of conceptual questions in the exam without sacrificing the ability to test student's ability to actually calculate an answer.

Homework was done by self-selected groups of up to five students per group in an attempt to formalize the informal student-to-student interactions necessary for learning[2]. It was also hoped that more formal student-to-student interactions would encourage more student-motivated student-instructor interactions from the distant students. E-mail from students and questionnaire results from previous semesters of the broadcast section of dynamics indicated a persistent sense of isolation from some of the distant students. It was intended that formalizing the practice of developing "study buddies" among the students and by the instructor calling attention to the frustrations students have reported in communicating with the distant instruction that some of the interaction oriented frustration with the broadcast environment could be alleviated. Three graded homework group surveys were administered, one before each exam, to judge students' participation and expectations of their groups and help with group management.

To increase student participation in the class and "ownership" of the course content[3], each student had to present an example problem to the class. The fall 2008 offering was the first time students presented example problems. The example problem serves both as a short synthesizing experience[4] for the students, and also as an excuse for e-mail interaction between the professor and each student individually.

An objective measure of course content assimilation was applied during the Fall 2008 broadcast offering of Dynamics in an attempt to develop successful methods of mitigating the perceived limitations of the broadcast environment. The Dynamics Concepts Inventory[5] was used as a pre- and post-course assessment, independent of graded problem-solution and conceptual style problems used on the exams, to judge the effectiveness of content delivery. With an objective measure of content assimilation available, the effects of changing course format, student

engagement strategies, textbooks, and other tools in the lecture style of delivery could be assessed. The improvement results from DCI scores from previous semesters indicated that more conceptual discussion of course material was necessary to enable thorough understanding of the material[6]. A consistency in pre-course DCI scores while a bi-modal grade distribution developed on calculation style graded assessments indicated that some students in previous semesters required intervention for inadequate math and calculus skills.

The hypothesis of the original research regarding this dynamics class was that interactive broadcast is effective for not only generating the desired student learning outcomes of a particular class, but also for creating the learning experiences necessary to develop excellent engineers. This research was motivated by a customer expectation in hiring the graduates of the remote program. That a strong and persistent sentiment against broadcast course delivery exists is well documented[7]. When that sentiment is expressed by the person who is both in charge of hiring engineering graduates for his organization and supplying a full time instructor to the remote program, it carries significant weight in program development. Hence, the research hypothesis asserting the efficacy of the broadcast method, and employing an objective measure of content assimilation, was developed to mitigate the primary customer's negative sentiment with the content delivery method.

The remote program has developed as an alternative to "brick and mortar" institutions for obtaining engineering degree objectives in a region underserved by traditional Universities. The program is neither taught in-person by part time temporary adjuncts nor asynchronously, either on-line or by other means such as correspondence[8]. It relies on real-time live interactive broadcast for delivery of the majority of junior and senior-level courses. Lower division content is supplied by the local community college. Laboratory classes are delivered on dedicated facilities at the remote site by the full-time instructor.

Streaming Video Technology

The baseline broadcast technology for this course is a pair of similarly equipped studio classrooms over 200 miles apart both in standard University classroom buildings. Polycom instructional broadcast systems have both instructor and student focused cameras. Three screens display the content and instructor views at the front of the room and the distant students at the back of the room, as shown in figure 1. The instructor controls the camera views and content images from a control panel at the front of the room. A Blackboard website supports the course. The content storage tools for keeping the syllabus and course notes, the gradebook function, assessment and survey tools, and occasionally bulletin board and chat room features in Blackboard are used to enhance the in-class instruction.

Figure 1: Studio Classroom at the remote location

Elluminate*Live*! has been embedded in Blackboard for the main campus since 2007. As a tool under the Blackboard shell for this class, it can be accessed only by students registered for the class or those specifically added by the instructor. Copyright protections are thereby maintained. And, the privacy of the classroom is maintained, unlike with open websites and chatrooms. The blackboard data base for the class and availability of its chatrooms enhance the communication potential of the system. University of South Florida and Northern Arizona University are both prominent in use of and research into the effectiveness of Elluminate*Live*! for content delivery[8], although not in Engineering.

There are several suites of Voice Over Internet Protocol (VOIP) webcasting technologies available for use by education professionals including Acrobat Connect, WebX, LearnLinc, and Live Meeting[9]. Elluminate*Live*! is resident at the main campus and supported by the digital campus organization. Elluminate advertises itself as "a virtual environment optimized for learning[10]". Some might call it a virtual classroom, or a specialized internet video conference system. It provides the functions of real-time streaming video and audio in a whiteboard frame that allows the professor to show content and write in real-time, as shown in figure 2. Students interact with both the professor and the content through typing, talking, video, or manipulating content, depending on the system capabilities of the student computer. Sessions can be recorded, or not, at the moderator's discretion. Moderator privileges can be assigned by the course instructor. Desktop applications can be shared and manipulated between session participants. (As a side note, Solidworks™ is sufficiently resource intensive that trying to manipulate Solidworks content through Elluminate inside of Blackboard crashes the computer. I have been able to manipulate Word documents, Excel files, and play solitaire on a student's machine through our system.)
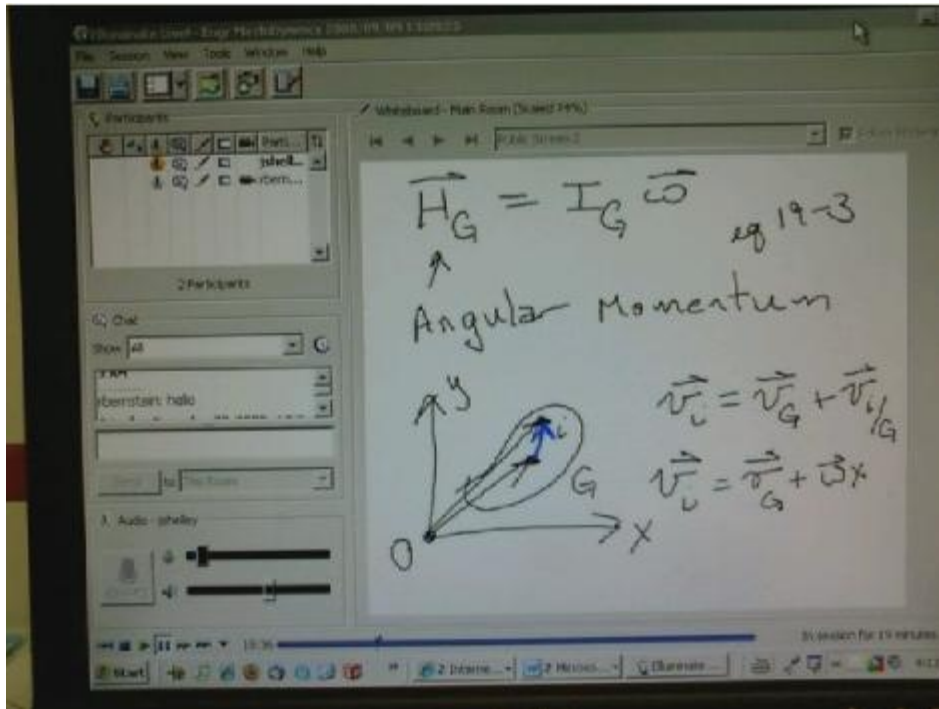
Figure 2: Picture of the Elluminate*Live*! screen recorded on 20 Nov 2008

Literature reviews appear to indicate that health care, mostly nursing, and teacher education are largest adopters of streaming technology for content delivery at this time. Many schools offer master's level classes in engineering through on-line synchronous and asynchronous delivery. While programs like University of Illinois NetMath[11] have shown success with on-line content in mathematics, no University so far discovered advertises complete undergraduate engineering degree objectives on-line. University of North Dakota offers on-line courses through a correspondence model using recorded lectures[12], but laboratory classes must be attended on-campus. While streaming video and other web-based technologies are revolutionizing content delivery and access to educational degree objectives in other fields of study, such as MBA programs, undergraduate engineering has yet to prove the efficacy of these technologies and fully embrace them.

For this Dynamics class, Elluminate was used to deliver traditional lectures and problem recitation. Students were not informed prior to the first day of instruction that the class was to be broadcast. However, the class was informed in the syllabus and during the first class session that Elluminate streaming technology *might* be employed during the semester for special exam review sessions, office hours, and homework help sessions. Streaming technologies had been investigated over the summer as a means to enhance student-teacher interactions and grant more convenient face-to-face office hours for the distance students in this synchronous distance learned class. In the Fall 2008 session, it was planned to experiment with Elluminate to enhance the broadcast course delivery in non-critical support functions, not to replace the broadcast classroom. However, regular lecture delivery through Elluminate began on the fourth class period (second week) of the 16 week semester and continued exclusively for about 4 weeks.

After the second exam, seven weeks into the semester, the original broadcast functionality was restored to the studio classroom and lectures were then streamed and broadcast live simultaneously from the broadcast classroom for the rest of the semester. Overall, 22 of the 28 course sessions (not including exams) were recorded through Elluminate to the Blackboard course website.

Data and Results

There were four students in the direct-contact section of the class and 14 in the distant section on main campus. Of the four students who could have chosen to be face-to-face with the instructor for the entire semester, one chose to participate in lecture by Elluminate throughout the semester. One student experimented with Elluminate, then determined he needed to be face-to-face with the instructor and in the presence of other students to pay attention to course material. The two others chose to be in class with the instructor for almost the entire semester due to the convenience and the timing of their other classes. The distant students had the option of participating in lecture individually in real-time, participating together in small groups, or viewing recorded sessions. Because students had options of "attending" class in groups, it was difficult to know exactly how many students were actually participating in Elluminate sessions in real time by who was logged on. At least one distant student logged into Elluminate during class sessions all semester. But, similar to the face-to-face students, initial curiosity with the virtual environment faded as the semester went on and lectures became available through broadcast. At least six distant students logged on to an introductory session to Elluminate and seemed to enjoy (two local students were logged on in the room with the instructor during the session) interacting with the whiteboard and other content through Elluminate during the session. Yet, no student took advantage of this capability during the regular class sessions.

Several sets of data exist for the streamed section of Dynamics. Blackboard records statistics for system usage. However, those data are incomplete and only minimally illustrative of the class activity. Only the data for the month of December are completely available. Blackboard records only "hits", log-ins, to particular sections of the website. It does not record how long or in what manner students used the material posted. For example, about 20% of the blackboard activity was in the Elluminate area, while most of the activity, 42%, was in the announcements section. However, the site was set to open on the announcements page so every initial log-in to the site generates a "hit" to the announcement page, regardless of what content area is "hit" next. Similarly, accomplishing a single task that requires repeated activity in one content area generates several "hits" to that area. In this case, returning exams by e-mail to students individually generated 13 "hits" in the e-mail content area to complete one task, while recording an entire class period of lecture generated only one "hit" to the Elluminate content area. Therefore, the Usage Statistics, shown in the pie chart in figure 3, for the instructor for the last two weeks of the semester show 8% of the blackboard "hits" in the Elluminate content area (Communications), 42% in the e-mail area, and 68% in the gradebook. However, personal time records indicate that the Elluminate recordings where approximately 6 hours of instructor time (not including preparation), the e-mail section required approximately 1.5 hours, and gradebook about 30 minutes. Interestingly, the usage statistics do not show student activity in the course documents section of the site, even though the class notes are posted in that area. So, while the usage statistics can illustrate which content areas of Blackboard students are "hitting", it can not

illustrate how valuable students find that information or how much time they spend interacting with the material. (As a side note, the number of "hits" to the gradebook content area by students after finals week does illustrate the value students see in being able to check their grades online.)
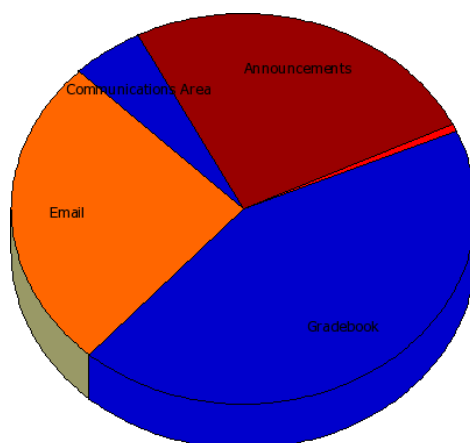

Figure 3: Instructor Blackboard Usage 1-15 Dec 2008

The Blackboard Usage Statistics for the times which students used Blackboard shows a majority of "hits", 11% of the total, where during the class times of 9:30 to 11 am, which should be expected for a class meeting through Blackboard. The second most frequent use, 10.8% of all log-ins, were in the 4 pm hour. Only two hours of the day had no log-ins, the 2 am and 4 am hours. These statistics appear to indicate that students will make use of on-line course "enhancements" outside of regular class times, even if it is just checking their grades.

That students appreciate having information available outside of class times is also illustrated by the breakout of data by week day. Taking the week of 1 Dec as an example, Blackboard shows no student log-ins during the Tuesday and Thursday class days, but 11 out of 18 students logged in over the weekend of 6 Dec. All checked grades, and two also "hit" Elluminate content. Observations of the distant classroom indicate that the distant students attend class more regularly on Tuesdays than on Thursdays. The Blackboard data reflect this trend as well with 15.4% of log-ins occurring on Tuesdays and only 7.4%, the lowest percentage, occurring on Thursdays. Just over one quarter, 25.4%, of the log-ins occurred on Saturdays. 11.7% of the Saturday log-ins appear are the instructor accessing the gradebook, email, and announcements, implying that the students access the site more frequently on the weekends than they do on Thursdays and Fridays. Overall, 42% of log-ins occurred over the weekends.

However, as figure 4 shows, log-ins to blackboard are only very weakly correlated to grades for this class, with a correlation coefficient of 0.25. While there are high scoring students who do not frequently log-in, there are no low scoring students who do log-in frequently. One snapshot of the 11 students who logged in to Blackboard on Saturday 6 Dec 08, shows that neither the highest scoring nor lowest scoring students "hit" online content that day. Since the class was not originally planned for on-line delivery and students could access almost all the required course content during the broadcast sessions, correlation between grades and blackboard usage should not be expected.
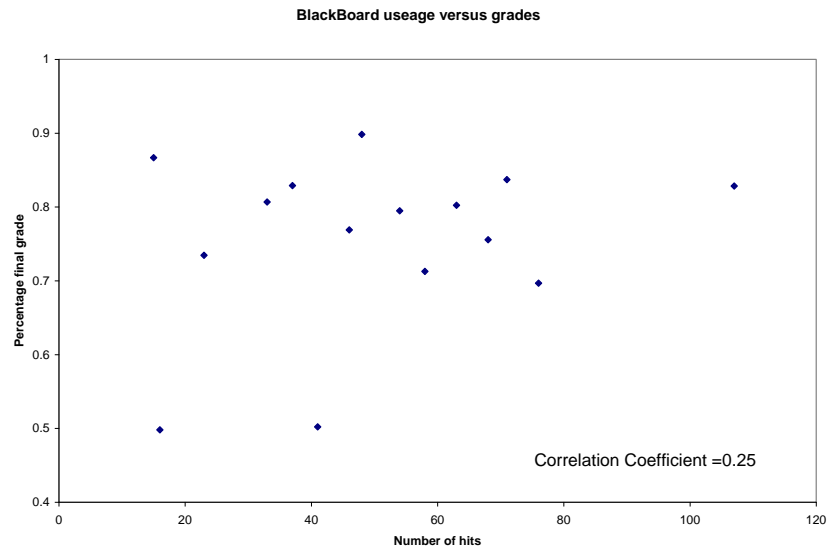
Figure 4: Student Blackboard Usage in December 2008 versus Final Course Grade

Another data set that exists for the Fall 08 offering of Dynamics is the results of the Dynamics Concepts Inventory. The results for this class were in-family with the results of previous semesters with the average score being not quite one standard deviation above the 6 correct responses expected by random guessing. 11 students took both the pre- and post-course inventories. Average score on the pre-course inventory was 9 correct out of 29 with a standard deviation of 3.6. The post course inventory average improved to 11 correct answers out of 29 possible, but the standard deviation also increased to 4.7. Two students of the 11 did not improve their score over the semester. These results are as expected from the results reported in the literature for lecture style delivery, as discussed in reference 6. While the final DCI correlates only moderately with grade achieved in the class (coefficient 0.45), *improvement* in DCI score is moderately *negatively* correlated with grades (coefficient -0.45), as shown in figure 5a and b. That DCI scores and grades correlate is within family for other strictly broadcast offerings of this course. The following semester, for example, grades and final DCI scores correlated with a coefficient of 0.48. However the grades and score improvement where uncorrelated with a coefficient of 0.15. Average scores for pre- and post course inventories where the same for those two offerings. These results indicate that the student's conceptual understanding of the material is somewhat reflected in the calculation style assessments used to generate grades. However, the calculation style of questions predominantly used on exams is not a complete measure of student's conceptual understanding. That the DCI scores and average improvement in scores are similar for several course offerings indicate that the lecture method of delivery is consistent in time and that streaming the lecture portion of the class in the Fall 08 semester did not significantly interfere with the student's ability to assimilate content.

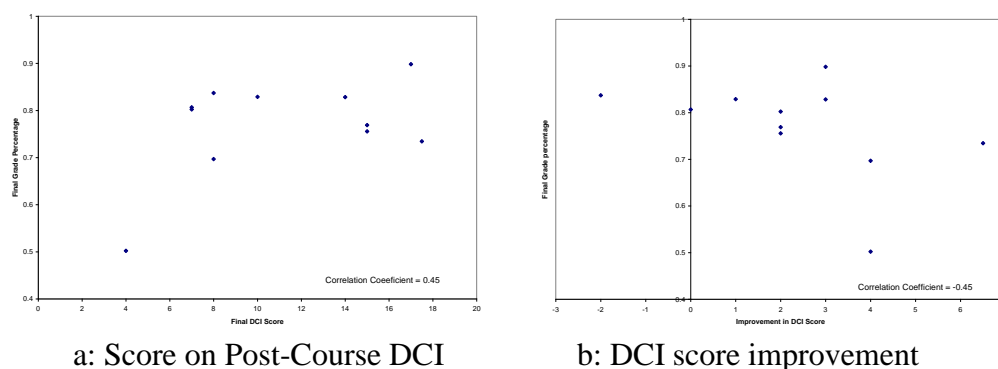a: Score on Post-Course DCI   b: DCI score improvement
Figure 5: Dynamics Concepts Inventory Scores versus Final Course Grades

The third set of data available for the streamed offering of Dynamics is results of an instructor-generated questionnaire used to gather information on specific activities of that semester. The questionnaire and results are in the appendix. 17 questions assessed that semester's broadcast environment and pedagogy via the class Blackboard website. 14 of the questions used a five point Likert scale. There were two open ended questions: "what did you like best" and "what did you like least" and one multiple choice. To incentivize student response, extra credit points were offered for completion of the questionnaire. The survey was administered on-line through Blackboard the final week of classes for the semester. Analysis of the responses was not conducted until after semester grades were submitted.

53% of the 13 students who responded to the Fall 2008 questionnaire felt that the quality of the broadcasted Elluminate sessions interfered with their ability to learn. This response was a large degradation from previous semesters where only 16% of students felt that the broadcast quality interfered with their ability to learn. At its worst, in spring 2006, the broadcast only section responded with over 43% reporting that the quality of the broadcast was poor enough to interfere with their ability to assimilate course content. Problems with the ability of students to stay connected to Elluminate during session and the generally poor quality of the broadcast of the Elluminate whiteboard were mentioned by students as frustrations with the quality of the broadcast. (Using the stylus to write on the whiteboard in Elluminate results in a more pixilated image than when using a stylus to write in PDF software on a tablet computer. When magnified for broadcast, the results are a "stylized" writing that is a blurry low resolution image projected at the main campus classroom. When the Elluminate whiteboard is viewed on its native computer screen, the pixilation is not as noticeable. Writing with a stylus is still "stylized", but it is legible and not blurry. After Fall 2006, the standard broadcast projects a native digital image from the tablet computer in high resolution at the main campus. The difference in resolution of the projected image alone accounts for the improvement of perceived broadcast quality from 43 to 16% dissatisfaction.) PowerPoint or other native digital text methods were not employed by the instructor. Broadcasting Elluminate sessions in their native high resolution format would require a different hardware and software configuration than currently available in the studio classroom.

The root of the student dissatisfaction with broadcast quality is neither with Elluminate itself, nor with the broadcast environment when it is properly employed.   The two technologies are not compatible on the system currently in use and the limitations of the technologies should be understood before choosing a method of content delivery.

45% of respondents agreed or agreed strongly with the statement that: "having class sessions on Elluminate was helpful to me." The follow-up question of asking students to explain how they used the Elluminate recorded material was not asked. However, 46% felt that using Elluminate was not worth the effort. 38% admitted that they did not take advantage of the recorded Elluminate sessions, while 23% said that used Elluminate to "attend" class over half of the time. Since the course was not intended for streamed delivery, that any students found the method useful, is encouraging of the technology.   That nearly a quarter of the population did make use of the time- or location- shifting potential of streamed content indicates that there is demand, even on a standard University campus, for streamed content.

31% felt they did not have sufficient interaction with the instructor to learn the material, although all respondents agreed that e-mail interaction was acceptable. A follow-up question probing what mechanisms would be useful in creating interaction with the instructor was not asked. Similar questions asked of previous broadcast sections of Dynamics where the students were not told ahead of time that the class was broadcast indicate that about a third of the students crave the physical presence of the instructor, regardless of what other mechanisms of interaction are available. Observations of other classes and of the remote students with their main campus instructors anecdotally suggest that some students have difficulty initiating interaction with the instructor and the lack of physical presence is an additional impediment to interaction. These observations indicate that student perceptions of student-motivated interactions and methods of developing student-motivated interactions may be a useful line of inquiry in further developing either broadcast or streamed courses.

When asked what they liked best about the course, four respondents specifically mentioned having sessions on Elluminate. Two other responses mentioned the instructor's flexibility in expectation of student attendance. One response lauded the instructor's availability and speed of e-mail responses. These positive responses appear to indicate that there is demand for the flexibility inherent with recorded streamed content, as long as the instructor is available and responsive.

When the students were asked what they liked least, only one respondent directly mentioned Elluminate because it was difficult to read the projection of content. Four responses addressed the broadcast environment, projection quality, and that the instructor was not physically present. One respondent indicated that classroom discipline at the remote (main campus) site was a significant issue saying "not having an instructor present caused some students to lack the ability to shut up during lecture." (The classroom does not have open microphones.) Two responses indicated problems with instructor time management and crowding too much material into short sessions. These negative responses indicate that many of the problems experienced during this class resulted from poor classroom discipline among the students and inadequate application of technology rather than from the streaming process or broadcast technologies themselves.

When asked if they would take another course via Elluminate 38% agreed, but no one strongly agreed. 15% strongly disagreed and 23% neither agreed nor disagreed. These responses appear to indicate that while there may be some demand for streamed content in engineering, there is a segment of the student population that is heavily invested in the traditional classroom environment.

The last information available for this class is the observations of the instructor. Elluminate*Live*! is a powerful tool and only a portion of its capability was used for this class. It can be used easily to support video teleconferences with students for office hours, or casual discussions. However, the overhead in learning the system and preparing course content is significant. And, the ability of students to interact with the system is not uniform across the student population. It is limited by their individual system capabilities. To fully utilize Elluminate to create learning outcomes in students requires a different approach to the learning environment.

With that understanding, this instructor found streaming content, even under duress in a non-ideal situation, preferable to broadcast lectures. There is the potential for asynchronous access of content, and potential for the convenience of geographical insensitivity for both the instructor and student. The difficulty of maintaining discipline in the distant classroom is removed. Students participating in streamed sessions are already accepting of a technological intermediary to student-instructor interactions. Streaming also creates the illusion that each interaction is individual and personal[13]. The illusions created by and honesty of internet interactions could be able to be exploited to the student's benefit in creating understanding of subject matter and learning outcomes. It should be possible to use the anonymity of the internet and the capability of Elluminate to create a pedagogy that simulates personal tutelage, stimulates inquiry, and creates a safe environment for students to challenge their preconceived notions, or lack thereof, about motion and the unbalanced forces that cause it.

Conclusions

Contingency plans for employing technology enabled classrooms need to be broad and complete. Planning for only the loss of ability to communicate between sites and for short term loss of capability was insufficient in this case. Planning should include contingencies for complete system failure.

Where non-traditional classroom environments are to be employed, students should be informed before the class starts. Mechanisms for managing the distant classroom and enforcing classroom discipline should be developed. Sometimes intrusive methods of ensuring interactions between distance course participants are required.

While there appears to be demand for time and geographically independent content delivery even among students on the main campus of a University, there is also strong sentiment against such content delivery. That students on campus have different expectations for how learning outcomes are to be developed should be considered before porting required classes to non-traditional delivery methods.

Elluminate*Live*! is a very capable package. Only a small portion of its capabilities were employed for this class. A course developed with significant native digital format content, such as PowerPoint slides, "virtual laboratory" simulations, and application sharing could be streamed with live real-time interaction very easily. The potential for Elluminate as a mechanism for developing student learning outcomes is great, but will require careful forethought, planning, and preparation of the students.

References

[1] Shelley, J. S. (2009) *Assessing Student Learning Outcomes in a Broadcast Learning Environment: Application of the Dynamics Concepts Inventory*, American Society for Engineering Education Annual Conference, Sessions 2630, Austin, TX: ASEE.

[2] Ragan, L.C. (2000) *Good Teaching is Good Teaching: the relationship between guiding principles for distance and general education*; Journal of General Education; 49(1).

[3] Kohn, Alfie;(1996) *Beyond Discipline: From Compliance to Community;* Association for Supervision & Curriculum Development.

[4] Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R.E., Pintrich, P. R., Raths, J., & Wittrock, M.C. (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives.*

[5] Gray, G. L., Evans, D., Cornwell, P., Contanzo, F., and Self B., (2003). *Toward a Nationwide Dynamics Concept Inventory Assessment Test,* Proceedings of the 2003 American Society for Engineering Education Annual Conference, Sessions 1168, Nashville, TN: ASEE.

[6] Gray, G.L., Constanzo, F., Evans, D., Cornwell, P., Self, B., Lane, J.L., (2005). *Dynamics Concepts Inventory Assessment Test: Progress Report and Some Results*, Proceedings of the 2005 American Society for Engineering Education Annual Conference and Exposition, Portland, OR: ASEE.

[7] Russell, T. L. (1999). *The No Significant Difference Phenomenon: A Comparative Research Annotated Bibliography on Technology for Distance Education as reported in 355 Research Reports, Summaries and Papers*. Montgomery: IDECC.

[8] Santarelli, K. W. (2010) "*An Evolving Model for Delivering Engineering Education to a Distance Location*", Proceedings of the 2010 ASEE Zone IV Conference, Reno NV.

[9] Schullo, Shauna; Amy Hilbelink, Melissa Venable, Ann E. Barron (2007) *"Selecting a Virtual Classroom System: Elluminate Live vs. Macromedia Breeze (Adobe Acrobat Connect Professional"* MERLOT Journal of On-line Learning and Teaching, 3(4) downloaded 16 Nov 2009 from http://jolt.merlot.org/vol3no4/hilbelink.htm

[10] Elluminate Inc, http://www.elluminate.com/products/live/index.jsp Downloaded 14 Nov 2009.

[11] University of Illinois, http://netmath.uiuc.edu/ downloaded 5 Dec 2009

[12] University of North Dakota, http://distance.und.edu/engineering/, downloaded 5 December 2009.

[13] Joinson, A. (1999) "*Lack of Inhibition and the Internet*", The British Psychological Society's Social Psychology Section Annual Conference, Lancaster, UK, The British Psychological Society, 15 Sept 1999 retrieved from www.bps.org.uk on 6 Nov 2009

Appendix

Fall 2008 end-of-semester dynamics class environment questionnaire

Name	2008 DL survey
Attempts	13 (Total of 13 attempts for this assessment)
Instructions	Answer the questions honestly.

Question 1   Opinion Scale/Likert

Interactive broadcast is an acceptable way of taking a class.

Answers	Percent Answered
Strongly Agree	15.385%
Agree	38.462%
Neither Agree nor Disagree	23.077%
Disagree	23.077%
Strongly Disagree	0%
Not Applicable	0%
Unanswered	0%

Question 2   Opinion Scale/Likert

I would take another broadcast class.

Answers	Percent Answered
Strongly Agree	15.385%
Agree	30.769%
Neither Agree nor Disagree	38.462%
Disagree	7.692%
Strongly Disagree	7.692%
Not Applicable	0%
Unanswered	0%

Question 3   Opinion Scale/Likert

The quality of the broadcast did NOT interfere with my ability to learn the material covered in class.

Answers	Percent Answered
Strongly Agree	15.385%
Agree	30.769%

Neither Agree nor Disagree	0%
Disagree	46.154%
Strongly Disagree	7.692%
Not Applicable	0%
Unanswered	0%

Question 4   Opinion Scale/Likert

Having the class sessions on Elluminate was helpful to me.

Answers	Percent Answered
Strongly Agree	30.769%
Agree	15.385%
Neither Agree nor Disagree	15.385%
Disagree	15.385%
Strongly Disagree	15.385%
Not Applicable	7.692%
Unanswered	0%

Question 5   Opinion Scale/Likert

The convienice of having sessions recorded on Elluminate was NOT worth the effort.

Answers	Percent Answered
Strongly Agree	23.077%
Agree	23.077%
Neither Agree nor Disagree	15.385%
Disagree	15.385%
Strongly Disagree	23.077%
Not Applicable	0%
Unanswered	0%

Question 6   Multiple Choice

I used Elluminate to 'attend' class either out of the classroom or at a different time.

Answers	Percent Answered
Over half of the class periods of the semester.	23.077%
Occasionally during the semester.	38.462%
I never needed to during this class.	15.385%
I did not want to be out of class.	23.077%

Unanswered	0%

Question 7   Opinion Scale/Likert

The E-mail interaction with my instructor was acceptable.

Answers	Percent Answered
Strongly Agree	69.231%
Agree	30.769%
Neither Agree nor Disagree	0%
Disagree	0%
Strongly Disagree	0%
Not Applicable	0%
Unanswered	0%

Question 8   Opinion Scale/Likert

Having the students present example problems in class was helpful to me.

Answers	Percent Answered
Strongly Agree	30.769%
Agree	46.154%
Neither Agree nor Disagree	23.077%
Disagree	0%
Strongly Disagree	0%
Not Applicable	0%
Unanswered	0%

Question 9   Opinion Scale/Likert

Having to present an example problem in class helped me learn the material.

Answers	Percent Answered
Strongly Agree	38.462%
Agree	53.846%
Neither Agree nor Disagree	7.692%
Disagree	0%
Strongly Disagree	0%
Not Applicable	0%
Unanswered	0%

Question 10   Opinion Scale/Likert

Working in homework groups helped me learn the material covered in the class.

Answers	Percent Answered
Strongly Agree	0%
Agree	30.769%
Neither Agree nor Disagree	30.769%
Disagree	23.077%
Strongly Disagree	7.692%
Not Applicable	7.692%
Unanswered	0%

Question 11   Opinion Scale/Likert

Having to do homework in groups interfered with my ability to practice the material enough to do well on the tests.

Answers	Percent Answered
Strongly Agree	7.692%
Agree	23.077%
Neither Agree nor Disagree	30.769%
Disagree	30.769%
Strongly Disagree	0%
Not Applicable	7.692%
Unanswered	0%

Question 12   Opinion Scale/Likert

I felt I had sufficient interaction with the instructor to learn the material covered in class.

Answers	Percent Answered
Strongly Agree	7.692%
Agree	23.077%
Neither Agree nor Disagree	38.462%
Disagree	23.077%
Strongly Disagree	7.692%
Not Applicable	0%
Unanswered	0%

Question 13   Opinion Scale/Likert

The lack of interaction with the instructor frustrated me.

Answers	Percent Answered
Strongly Agree	0%
Agree	23.077%
Neither Agree nor Disagree	46.154%
Disagree	0%
Strongly Disagree	23.077%
Not Applicable	7.692%
Unanswered	0%

Question 14   Short Answer

Short answer: The thing I liked best about the way ME 112 was run this semester was:

Unanswered Responses
1

Given Answers
The example problems presented by the students were usually helpful, the person presenting the problem usually took a different approach to the problem than I would have, and a different approach than would have been taken during the main lecture.
testing timing in other words the time the test were set during the semester, so we had time to participate.
being able to have some flexibility in class attendance.
it was convenient the way the classes are available on time but i never used it.
I really liked the elluminate
I liked that the instructor was flexible about things.
The recording of elluminate sessions to review after class, as well as the downloadable notes of each class.
That the teacher took the time to always be available if we needed help and was fast to respond to emails.
Homework groups
I liked elluminate, presentations, i also liked the subject.
i like the example problems because I think they helped me prepare for the exams because they were exam questions that you had previously used on past exams.
I loved the instructor. She made it fun =)

Question 15   Short Answer

Short Answer: the thing I liked least about the way ME 112 was run this semester was:

Unanswered Responses
2

Given Answers
The use of class time didn't seem very good. That was largely due to problems with the distance learning set up. But I think Dr. Shelley could be a bit more efficient in the use of class time as well. I would also prefer that the class be a three (or four) day a week class, there is a lot of good material in there but it is fairly intense and that made it hard to focus on the material at hand for the last 20 minutes of the class.
Some tech issues, which delayed the start of our sessions. Other than that, class was great and fun.
that not having an instructor present caused some students to lack the ability to shut up during lecture.
The fact that it was a distance learning class. The only reason I enrolled was because it was the only dynamics class left open, the others were already closed.
elluminate was bad because could not really see anything in class.
Not being in person
nothing
The material in this class is very complicated and face to face interaction may have been best. Also trying not to cram so many chapters into the time slot available. I do not really understand chapter 19,22,20 especially the relative frame motion.
Lectures were kind of short
That I did not know it was a broadcasted class when i first signed up.
I think that this symester had a lot of problems with technology. It was hard for me to make out the board when the camera was pointed at the projector screen.

Question 16   Opinion Scale/Likert

ME 112 could be made totally on-line with recorded lectures and chat-room homework recitatio periods.

Answers	Percent Answered
Strongly Agree	7.692%
Agree	15.385%
Neither Agree nor Disagree	0%
Disagree	46.154%
Strongly Disagree	30.769%
Not Applicable	0%
Unanswered	0%

Question 17   Opinion Scale/Likert

I would like to take other courses via elluminate or with elluminate recorded class sessions.

Answers	Percent Answered
Strongly Agree	0%

Agree	38.462%
Neither Agree nor Disagree	23.077%
Disagree	23.077%
Strongly Disagree	15.385%
Not Applicable	0%
Unanswered	0%