A SYNCHRONOUS DISTANCE-EDUCATION COURSE FOR NONSCIENTISTS

Coordinated Among Three Universities

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With the goal of exposing non-science-and-engineering (NSE) students to the principles and ethical issues of nanotechnology, the course "Concepts of Nanoscience" began as a proposal—"Ethics of the Nanoscale"—to the National Science Foundation. The proposal included several educational components including, but not limited to: 1) exposing freshman non-science majors to nanotechnology, an emerging technological field; 2) incorporating ethics into science courses; 3) intra- and inter-university team teaching; as well as 4) exploring the benefits and challenges of multi-university asynchronous and synchronous distance education (SDE) formats. This discussion is limited to the details of offering the course in SDE format jointly among Auburn University (AU), Tuskegee University (TU), and Auburn University at Montgomery (AUM). Details related to course content and other aspects of the program are discussed elsewhere.[1]

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The advent of the Internet and ubiquitous high-speed data transmission have made SDE an attractive educational format. The SDE format is one in which data are transmitted to students in real time as opposed to an asynchronous format, which typically involves recordings. Advantages of SDE when compared to traditional "brick and mortar" classrooms are the obvious time and energy savings associated with individuals not being required to gather in one location. Studies suggest that students taught the same course in traditional and SDE formats perform similarly.[2] Thus, choosing an SDE format is a neutral choice with respect to student outcomes. Two disadvantages of any distance education format, however, are limited direct contact with the instructor and the potential for technical complications, both difficult to overcome.

An SDE format may use video, audio, graphics, and combinations of the three.[3] Standard videoconferencing equipment or Internet-based software can facilitate two-way communications for SDE. Multi-point (three or more transmitting sites) efforts are more complex, however, and may require a hub or bridge. Another feature of SDE is that students may be gathered in two or more classrooms, sitting alone at remote computers, or combinations of the two.

Various disciplines have investigated the SDE format.[4, 5] This discussion, however, is limited to science and engineering courses and programs. One prominent example of an SDE effort is the Singapore-MIT Alliance for Engineering Education, which focuses on professional master's programs and also Ph.D. educational programs.[6] The alliance began in 1998 and has expanded to include a more research-centric phase. The alliance includes three institutions: the Massachusetts Institute of Technology (MIT), the National University of Singapore, and Nanyang Technical University. Typically, students are gathered in classrooms at the three institutions where video, audio, and graphics data are transmitted. In addition to typical coordination and technical difficulties inherent in this type of effort, the alliance faces the exceptional challenge of a 12-hour time difference. Despite challenges, the alliance has been very effective and emerged as a leader in international distance education.[7]

The Electrical and Computer Engineering Department at the University of West Florida in Pensacola offers SDE courses to the Fort Walton Beach Campus.[2] The courses are two-way transmissions between a classroom on each campus. The distance-education effort, which began in Fall 2002, involves the simultaneous transmission of video, audio, and graphics data using Polycom videoconferencing systems and an interactive pen display and multimedia lectern manufactured by SMART Technologies, Inc. An assessment of the SDE program indicated that students at the main campus and off-site campus passed at similar rates of 67.9% and 66.7%, respectively. Additionally, students at the off-site campus were administered a survey to gain feedback on their experience in the SDE course. The survey indicated that 1) students preferred synchronous distance education to asynchronous distance education, 2) one drawback of SDE was lack of direct interaction with the instructor, and 3) students valued the availability of SDE.

The School of Information Technology and Engineering at George Mason University has offered SDE since 1994.[8, 9] The number of SDE courses has grown from one course in 2000/2001 to 24 courses in 2003/2004.[9] Moreover, George Mason's experience has provided the following observations related to SDE[8]:

1) *Most students would prefer a traditional course format but, for those who chose SDE, the disadvantages of the SDE format do not outweigh disadvantages of traveling to a traditional classroom.*
2) *In the absence of the inconvenience of travel, some students still prefer SDE because of their learning styles.*
3) *Consistent with other groups,[2] studies that compare SDE to traditional classrooms suggest no significant difference with respect to student outcomes.*

Lastly, the Georgia Institute of Technology School of Engineering has been involved in SDE since as early as 1991 with the offering of an online master's program in electrical and computer engineering from both the main campus and a satellite campus in Metz, France.[10] Georgia Tech also participates in an academic collaboration with Georgia Southern University, Armstrong Atlantic State University, and Savannah State University to offer students at those campuses engineering degrees using several educational modes including SDE.

Clearly, the SDE format is not unique within science and engineering disciplines, but the course that the authors describe is unique because it targets freshman-level, non-science-and-engineering majors, whereas most efforts emanating from science and engineering departments target science and engineering majors. The motivation for the SDE course format for this course was fourfold:

1) *Real-time interaction of instructors and students on three different campuses*
2) *The efficient use of resources on the three campuses associated with combining three classrooms into one classroom*
3) *The optimal use of instructor expertise from the three campuses – the most qualified instructor from among the three universities was chosen to lecture on a given topic*
4) *The SDE format is on par with traditional styles with respect to student outcomes*

RESOURCE REQUIREMENTS

SDE efforts can be resource-intensive during the initial roll-out phase. For example, the purchase of a single videoconferencing unit can represent a significant capital investment of approximately $10K. Also, network staff resources are critical to address transmission issues related to firewall settings. Finally, there is a significant time investment by instructors to modify lecture content so that it is suitable for the SDE format.

Equipment

Distance education equipment was purchased (as necessary) and configured for all three universities. AU used a Tandberg director system which consisted of a 3000i Smart Board rear projector 67" display touch screen, a Tandberg 6000 Codex, audio ceiling microphones with electronic sound cancellation (eliminates microphones picking up the sound from the far end of the classroom and returning it as an echo), two wide-angle wave cameras, and a 12" Centronic touchscreen control monitor. TU used a Tandberg 770 MPX Portable unit that included one wide-angle wave camera, a 32" monitor, and a roll cart. AUM used a Vitel Video Conference System that included two 32" monitors, two wide-angle cameras, and 12 table microphones.

All three institutions had access to views of the other two institutions during lectures but, typically, the lecturing institution was viewed unless another institution was asking a question. Because the course was viewed in real time, it could be and was very interactive. This opportunity for an improved extended-classroom dynamic couldn't be realized for a distance education course that is asynchronous.

Facilities

Figure 1 shows the configuration for the SDE transmissions. The Intercampus Interactive Telecommunication System Office at the University of Alabama at Birmingham (UAB) facilitated the three-way interaction of the participating institutions and provided streaming archiving for asynchronous lecture viewing. Special classrooms were not required, but access is critical. Most universities schedule classrooms to be occupied most of the day. Consequently, if transmission issues need to be resolved, limited access to the exact Internet port that is used can cause unnecessary course delays.

Staffing

Auburn University, the lead institution for the course, provided a media support instructional technologist who attended all lectures and was the technical coordinator and contact person for technical issues from all three campuses. Also, initially, network staff from all three campuses were integral to the course to address firewall issues and other technical issues that arise during transmission. The Singapore-MIT Alliance found that the best practice is to move the course transmission outside of the firewall.[6] If network administrators are not comfortable with operating outside of the firewall, however, satisfactory transmission can still be achieved. After the initial resource-intensive phase, network staff should still be available for emergencies to prevent interruption in course instruction.

MULTI-UNIVERSITY INSTRUCTION: STRUCTURE AND EXECUTION

Several logistical issues needed to be addressed related to multi-university SDE instruction. First, each university is on a different class schedule. Graduate student schedules are typically very flexible and permit deviations from standard class start times (*e.g.*, on the hour) and course blocks (50 minutes, 80 minutes, etc.), but undergraduate schedules are much more constrained. As a result, course scheduling was a significant challenge. Both AU and TU offer Monday/Wednesday/Friday (MWF) and Tuesday/Thursday (TTh) courses, but AU starts on the hour and ends at 10 minutes until the hour, whereas TU starts at 10 minutes after the hour and ends on the hour. AUM does not have class on Friday. The compromise was that the course would be offered MWF with 40 minutes of core content. AU handled issues like homework and announcements for 10 minutes before class, and TU handled those issues for 10 minutes after class. All sessions were recorded, and AUM viewed the Friday lecture off-line.

Another issue was the scheduling of institutional breaks. Each institution had different spring breaks, semester start/end dates, holidays, etc. Long breaks such as spring break were coordinated by viewing recorded lectures during those periods. The semester start/end dates in some cases were close enough for all three institutions to coordinate and in other cases were handled by temporary asynchronous viewing.

Course Offerings and Enrollment

The course was offered during the Spring 2007 and Fall 2007 semesters. Course enrollment data are provided in

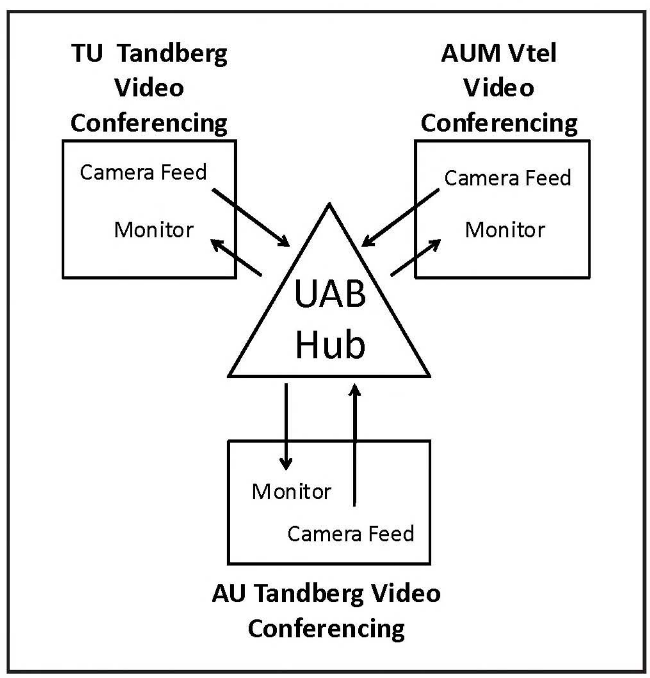

Figure 1. *Multi-University Synchronous Distance Education transmission configuration.*

Table 1. Enrollment (pre-test participation) was significantly higher at Auburn University because the course was one section of an established course. At Tuskegee University, the course was acceptable for "science elective" credit but, despite heavy advertising, students and advisors were accustomed to more traditional courses and chose those. Enrollment at AUM was affected by the lack of a laboratory offering, since all majors must have two laboratory science classes to meet basic curriculum requirements. At AU, the lower division "Concepts of Science" course, which is targeted at non-science majors, has a recitation hour instead. The curriculum committee at AUM would not allow a recitation to be substituted for a laboratory.

Student Outcomes

Student learning for the purpose of assigning a grade was assessed using four in-class exams and a comprehensive final exam. The impact of the course, however, was assessed by administering pre-course/post-course tests to the students. The results of the pre-test and post test are outlined in Table 1. The pre-test was administered to establish the baseline for student knowledge of the subject matter. Typically, the post test was administered after the final lecture but prior to the final exam. The pre/post test consisted of 32 questions (24 True/False type and eight short-answer). Table 1 shows the number of students participating from AU, TU, and AUM and their corresponding pre/post test average scores. For AU, all students who completed the pre-test did not complete the post test, and the pre/post assessments were not matched in the end because of Institutional Review Board (IRB) restrictions. Consequently, it was possible that the students who scored the lowest on the pre-test did not take the post test and thus inflated the score difference. To remove this error, the pre-test results reflect both the average of all the students tested and the average of the students scoring highest on the pre-test corresponding to the same number of students who took the post test at AU. The second number reported in the score difference column gives the most conservative estimate of student learning because it is calculated from the arbitrarily higher pre-test scores. Another issue is that 24/32 questions were True/False type, implying a baseline of zero knowledge at a score of 12/32 or 37.5% for random guessing. Despite the aforementioned challenges with the assessment exercise, it is clear that the students' knowledge of the subject matter improved significantly, ranging from 7.8 to 29.2%. In addition to increased knowledge of nanoscience, students were also able to benefit from the expertise of faculty from multiple campuses and gained insight into the culture of other campuses.

Clearly, the assessment data revealed that the students' knowledge of the concepts of nanoscience improved. The overall course drop rate, however, was 41% for the first semester and 33% for the second semester. In addition, overall enrollment dropped by 43% from the first to the second semester. Based on anecdotal evidence, a number of factors including but not limited to course difficulty, unbalanced course content, and technical difficulties contributed to the decrease in enrollment. Because multiple factors influenced course enrollment, it is difficult to isolate the contribution of the SDE format in the absence of survey data.

For the SDE course described, students gathered in one location at their respective campuses where traditional classes were also offered. Thus, the common SDE benefit of saving the time, energy, and inconvenience of traveling to a distant location was not realizable, and the primary benefit to students was the optimization of faculty expertise from three campuses. It is the opinion of several faculty, however, that the benefit of optimized faculty expertise may not outweigh the challenges of the SDE format for freshman non-science majors because the students are not advanced enough to appreciate the optimized expertise.

CONCLUSIONS

A synchronous distance education course joint among Auburn University, Tuskegee University, and Auburn University at Montgomery was successfully offered for two semesters to introduce non-science majors to the concepts of nanoscience. The majority of the lectures were conducted in real time so that students from all three campuses could interact with the various lecturers and students at other campuses. Although several logistical and technical issues were encountered, the

TABLE 1
Concepts of Nanoscience Enrollment and Assessment Data

School	Term	Pre-Test		Post Test		% Diff
		# Students	Avg. score (%)	# Students	Avg. score (%)	
AU	Spr 07	31	68.1/75.7	16	91.2	23.1/15.5
AU	Fall 07	18	67.8/72.8	11	89.1	21.3/16.3
TU	Spr 07	4	62.5	4	70.3	7.8
TU	Fall 07	2	60.9	2	90.1	29.2
AUM	Spr 07	2	72.4	2	92.6	20.2
AUM	Fall 07	1	-	1	-	-

course ran satisfactorily for two semesters with the support of networking staff and limited asynchronous viewing of recorded lectures. Analyzing the results of assessment tests given to students revealed that their knowledge of the concepts of nanoscience improved by 7.8% to 29.2% as a result of completing the course.

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