AC 2012-4064: SYNCHRONOUS DISTANCE LEARNING FOR UNDERGRADUATE THERMAL ENGINEERING COURSES: TRIALS AND IMPROVEMENTS

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Synchronous Distance Learning For Undergraduate Thermal Engineering Courses Trials and Improvements

Abstract:

Distance learning has found wide spread use in numerous disciplines. The authors are not aware of attempts to teach synchronous (live interactive) distance learning in undergraduate thermal engineering courses. Probably due to the mathematical nature, and numerous new concepts covered in courses such as Heat Transfer, this course is not considered the easiest, though it is one of the most valuable undergraduate engineering courses in Mechanical Engineering Programs. An attempt to teach Heat Transfer live interactively for an extension program at the same time it was taught in the main campus has been tried. The extension program has been designed for working students. Thus instruction for any extension course had to be offered one day/week in the evening for three hours, unlike normal undergraduate courses, which are offered for one hour three times per week. Synchronous distance learning was accomplished using a Learning Management System, with interactive virtual real time free software (DimDim). Numerous challenges arose, some were technical, and others created due to the skewed scheduling of main campus students. Surveys of students, and faculty observations, frustrations, and recommendations were evaluated. Then, the Information Technology Department, the Instructional Designer, and the Engineering Dean helped either by ideas or financially by introducing other alternative solutions. Once these solutions were in place, the same faculty taught the course Thermal Design of Heat Exchangers to three groups. Interactive video conferencing was used for one group, interactive real time using more reliable software, than the previous used. License for use of Adobe Connect was purchased and implemented for the second group; the third group was students on main campus, who were allowed to attend either class. A Learning Management System (Moodle) was used in conjunction with teaching the Thermal Design of Heat Exchangers for submitting homework and posting of different handouts. In this article, the authors discuss the three cases for live distance learning, the challenges faced with each, and comparisons between the three systems and face-to-face teaching. Recommendations for improvements are given in this article.

Introduction:

During the past decade Universities around the world embraced distance learning to increase student enrollment without building classrooms or resident halls. Numerous fields including master programs in engineering took advantage of distance learning. Distance learning appeals to mature working students and their employers as it does not disrupt the working day. Bourne et. al.[1] discuss the impact of online learning on continuing education of graduate engineers and degree seeking engineering students. They recommend that engineering colleges explore, implement, and extend blended learning and the collection of data and distribution of knowledge about successes and failures, as well as to continue to build-out the use of technology implementations that increase the quality of online courses. Mulligan et. al.[2] describe case studies for teaching online Manufacturing Technologies, and Manufacturing Management courses. Distance learning for electrical engineering laboratories has been extensively reported

in the literature for several years [3-5]. In the area of Thermodynamics, Sheyman [6] developed computer simulations for thermodynamics laboratory experiments. Another study on how students learn to design an online Thermodynamics course[7] was reported, and a Thermodynamics course [8] was taught using Adobe Connect and computer software. Other than these articles the authors are not aware of attempts to teach synchronous (live interactive) distance learning in undergraduate thermal engineering courses. This is likely because of the mathematical nature, and numerous new concepts covered in courses such as Heat Transfer. In addition Heat Transfer is one of the most difficult courses in the mechanical engineering undergraduate programs.

There are several methods of delivering distance learning, this article deals with synchronous (live interactive) distance learning.

Saint Martin's University is a small private religious university. The Mechanical Engineering program is ABET accredited. In 2003, due to the demands of industry the university started an evening extension Mechanical Engineering program at a location approximately 60 miles away from the main campus, followed in 2010 with another extension approximately 90 miles away from the other direction of the campus. With teaching overload of tenured/tenure track main campus mechanical engineering faculty, long driving distances, and hazardous driving conditions at night, the extensions had to rely completely on adjunct faculty. Main campus full time mechanical engineering faculty taught laboratory sections on weekends to the extension program students on the main campus. The rationale for offering engineering laboratories on main campus only, was due to the high expense of creating laboratories at the extensions; and also due to liability issues. Thus extension students had to drive to the main campus on Saturdays to perform experiments in laboratories affiliated with any course.

A number of problems faced the extension programs due to complete reliance on adjunct instructors except for the laboratories. Highly qualified specialized engineering adjunct instructors are hard to come by. Most of the adjunct instructors, who were recruited, teach temporarily until they find a higher paying engineering position in their area of expertise. Thus sometimes in the middle of a semester an adjunct instructor may quit. To overcome this problem and to guarantee the quality of the extension programs, the idea of broadcasting to the extensions came about. However, the cost was prohibitive, until the thermal engineering instructor and the instructional designer collaborated on an experiment with the first and second cases using a Learning Management System (LMS), with interactive virtual real time software. The third case was based on Interactive Video Conferencing (IVC)

Case 1: Heat Transfer Course with Laboratory using the free version of DimDim, a web conferencing software

At Saint Martin's mechanical engineering department, courses are offered once a year, due to the small size of the department. The Heat Transfer course is a 4 credit semester course; the lectures are three credit hours per week and the laboratory three consecutive hours that is counted as one credit. The Heat Transfer course is offered the spring semester, the lectures are offered during the day for fifty minutes three times a week for the main campus. While at the

extensions any course is offered in the evening for three consecutive hours, to accommodate the working students.

Before the start of the 2009 spring semester the engineering dean informed the first author that the adjunct who was supposed to teach the Heat Transfer course lectures has found a job. The first author could not locate a qualified adjunct in the vicinity of the extension, and consulted with the instructional designer. The instructional designer suggested the use of DimDim for live interactive broadcasting to be tried for the class, and then she set up the software.

DimDim was web-based software that allowed users to hold meetings and collaborate online, using rich media for file sharing, chat, forums, screen sharing and audio/video broadcast. It can be compared to other online webinar spaces such as WebEx or Adobe Connect. Although in 2011, this program was acquired by another company and was discontinued. At the time of the last two case studies, DimDim had a free version available for public use. This free version had sufficient features for the needs of the instructor. The limitations of the free version were the number of participants allowed into one course (under 20), the program also restricted the free version to holding one class at a time. This did not pose a problem since there were a small number of participants in the distance learning extension class and very few other instructors were using DimDim with no time conflicts between the different distance learning class offerings.

Another reason that DimDim was selected is because it was integrated with the course management system (Moodle) employed at the university. Because DimDim made some of its code available through open source, a low cost module allowed the instructor to set up meetings directly through their Moodle course page. Students could enter the meeting space through their Moodle course page as well. This promised to eliminate the need for directing students to yet another web location or remembering another set of user names and passwords.

Both the heat transfer instructor and the instructional designer first tested DimDim together, then with students and staff from the extension, before the beginning of the semester. They had identified several problems. One of these problems was an echo from the microphones. This was overcome at the start of the course by the faculty wearing a headset to maintain the quality of sound in the main campus face-to-face class instruction. While to preserve the quality of sound for the extension students, they were advised to keep their microphones off until one of them needed to talk and to wear headsets as well, to avoid an infinite loop feedback.

Due to lack of heat transfer instructors, both main campus students and the extension students were offered the class lectures once a week from 4-7 p.m. Main campus Heat Transfer Laboratory was held weekly for three hours on a weekday, while for the extension several laboratory experiments (two –three) were combined on some Saturdays, so extension students would not have to drive to campus very often. Thirteen students were enrolled on main campus; they varied in age and circumstances. Some of the main campus students were continuing students, some were transfer from community colleges, and others were returning students, some worked to support themselves, some had families to support, some lived on campus and some had long distances to drive back to their homes. While there were only two students on the extension campus, both students had full time jobs to support their families.

Both main campus and extension students were given a comprehensive and extensive seven page syllabus handout spelling out the details of conducting the class. Before the start of the semester, the extension students were e-mailed a handout on how to log into Moodle and access DimDim distance learning software. The main campus students attended in class (face-to-face instruction), while the extension students either attended at the extension, where the instructor computer station was set to display the lecture on the classroom screen, or they logged on their computers at home. The lectures were delivered using Microsoft Power Point, and examples were solved by writing on empty slides of Power Point or DimDim's white board using a tablet and a handwriting recognition pen. Homework assignments were regularly assigned and graded. Main campus students were assigned the homework one week before the due date, and homework was submitted in class. The extension students submitted the homework during the laboratory section, i.e. they had two to three weeks to complete the homework. Due to the small number of extension students, homework was graded while they were in the laboratory, and they were given immediate feedback. Three mid-term exams were held during the laboratory meetings, proctored by the heat transfer instructor to guarantee equity between both campuses. Term exams were conducted during the scheduled laboratory sections, thus the heat transfer instructor personally supervised both exams for main campus as well as the extension students when the extension students came to the main campus on Saturdays. Great care was exercised in preparing the exams to have both main campus and extension exams cover the same topics and have the same level of difficulty.

Problems Encountered

DimDim went out of service during scheduled lectures for maintenance, upgrades, or other technical issues, without prior notice, that resulted in loosing lecture time adding up to more than one week (equivalent of 4 classes) of instruction. Due to holding both classes together that lost time affected both main campus and extension student.

Main campus students were unable to concentrate in class, and most of them seemed sleepy. The main campus students started the first class at 8 a.m., while the Heat Transfer course started at 4 p.m. and ended at 7 p.m., an eleven hour day, with much concentration needed at the end of the day, was not conducive to learning.

The instructor was connected with the headsets wire to the computer and thus could not move from behind the podium. That style is not conducive to teaching due to loss of variation, making the class monotonous.

Several slides of DimDim's white board or power point were used to solve one problem; unlike writing on the front board of the class and using all its width to show the whole problem. Consequently main campus students were not able to grasp all the analysis of the examples. Though, the extension students, who attended from home, had a slight advantage of being able to flip through the slides of DimDim, while following the solution, this advantage was not available for the students attending through the extension classroom.

Any display on the document projector showed only on the board of the main campus class. Because of technical limitations, it was impossible to connect the document camera to the computer itself. In addition, the camera used to broadcast the classroom gave disproportionate dimensions, and could not readjust its location, to zoom in on display the demos.

Due to a limited bandwidth, there was always delayed transmission to the extension campus; the problem became worse with animation. According to extension students animation became completely distorted.

Surveys

At the end of the semester both main campus and extension students were surveyed for their opinion about the convenience of the class meeting time. Also, the survey had space for student comments. The result of the survey is listed in table I, while a summary of the student comments is given below. Strangely the four students, who marked neutral, indicated that they were unhappy with the late scheduling, and long lectures in the comments.

Table 1: Survey: Class was held Wednesdays 4-7 p.m.

Question	**Main campus**			**Extension Campus**		
	Yes	**Neutral**	**No**	**Yes**	**Neutral**	**No**
Does the meeting time and duration of the class work well for you?		4	9	2		

Summary of Main Campus Student Comments

- Heat Transfer is a tough subject to focus on for 3 solid hours. Hard for the brain to absorb
- One hour class more conducive for learning tough subjects, due to being exposed to the concepts several times a week
- Weeks work of material is crammed in one meeting, not conducive for learning
- Late evening classes are hard to concentrate
- Conflict with jobs.
- Conflict with university athletic team training
- Commuter students find it hard to drive home long distances late in the evening, particularly with none cooperative weather such as rain or snow
- Conflict with family obligations
- Small space for solving problems on DimDim white board slides, hard to follow
- Faculty needs to move and write on the front class board. Faculty located behind the podium is none conducive to learning.
- 'Why should I, who is paying more than $20,000 a year have to come in when it is better for a student who is most likely paying a fourth of what I am paying. I feel that the Main Campus students should be favored over other campuses since we pay more.'

The extension students' tuition was approximately a third of what was paid by main campus students. The preferential tuition scale aggravated main campus students, who were aware of that scale. This is an issue only local to this University.

Two main campus students were sick and logged on their computers to attend class. When asked how they liked it. Both indicated that they prefer to attend a face-to-face class, and that at home there are too many distractions.

Summary of Extension Campus Student Comments

- The time and duration are ideal
- As a distance learning environment, the distance learner has to be independent and self starter.

Both students indicated that attending at home was helpful in situations when they could not leave home because of obligations to their children.

Heat Transfer Faculty Observations and Opinion

The grades of the two extension students were within the standard deviation of the average of main campus students. Due to the small number of the extension students, any statistical analysis would not be reliable.

Heat Transfer is one of the toughest fundamental engineering courses due to its abstract nature. Most mechanical engineers, the heat transfer instructor meets outside of her employment, indicate that the Heat Transfer course was the toughest. Consequently, the instructor agrees with the students that 3 consecutive hours in the evening is too much for retaining any material. Also, the instructor is limited to using the computer, which deprives main campus students from varying teaching methods that can help reinforce concepts. The heat transfer instructor's personal observations were that students were too tired to concentrate on the lecture or participate; several students could barely open their eyes, an occurrence that repeated every class meeting. Meeting once a week for a tough subject does not give the students opportunity to absorb the material covered, as well as meeting three times a week for shorter periods. Based on teaching the same group of main campus students several other courses, the instructor felt that the students enrolled in this course did not perform to their full potential. Also, the instructor has spent many hours every week on the internet responding to the extension students' questions, some technical and some related on how to use Moodle, or other computer issues. Unlike face-to-face questions, where the instructor observes the body language and gives hints to the student to get the student going; e-mail responses usually create more e-mail questions. Unfortunately the instructor did not keep a log book for the time spent on the internet answering the two extension students' e-mails.

The instructor's final recommendation is to experiment with other tools and methods to meet the extension student needs, resulting in the methods used below for teaching Thermal Design of Heat Exchangers.

Thermal Design of Heat Exchangers

Thermal Design of Heat Exchangers is a senior undergraduate elective course. It was offered during the summer of 2011. Interactive Video Conferencing (IVC) was used for instructing the extension students. Based on the problems encountered in delivering Heat Transfer to the distance learning students, the former Dean of Engineering and the Information Technology Department purchased IVC, which consists of broadcasting to distant computers with the use of a camera, microphone and large scale dual LCD monitors. The cost of IVC was about $23,000. It is a point to point system, i.e. two locations could be connected at once. It was believed at the time that it can be used by four users. Because this was a bandwidth-heavy computer to computer connection, any additional equipment or audio sharing was problematic, slowing down applications such as use of a tablet and handwriting recognition pen.

Before enrollment started the first couple of students, on the main campus, who expressed interest in attending the distance course, due to work and long commutes, were given the option to use the IVC system. The rest of the students on main campus were required to attend the class in person. As a consequence, several students dropped the course because of internships and inability to drive to main campus.

At the start of the summer semester, the extension students complained that the size of the faculty on the monitor screen was reduced to one fourth, due to the use of all channels, which split the screen up equally. There was also a lag in timing, which made the Power Points run slow. Because of the limited connectivity, it was also impossible to share documents on the screen and many technological problems began to surface. It was becoming clear that this technology was not appropriate to the teaching and learning goals of the class. The immediate solution to this particular IVC problem would have been to purchase additional technologies at the prohibitive cost of another $30,000 – $40,000.

The instructional designer proposed Adobe Connect as a solution, which has been licensed to the University. After initial testing, it promised to avoid the technical problems encountered with DimDim.

The course was mainly delivered through lecturing, using Power Point, practical examples and involving the students in solving the examples, as well as pictures and animations of heat exchangers in operation. To engage the students; at times they were asked to cooperate together to solve problems in class, on the board of the extension classroom, or on Adobe Connect white board. Also, students applied their knowledge in solving design problems individually, these design problems were immediately graded and the comments on homework problems were posted in the university course management system (Moodle, for student feedback). Teams worked together on major projects. At the end of the semester each team presented their project and submitted a written report. There was a midterm exam and a final comprehensive exam. Thus the course was a combination of passive and active learning.

Case 2: Thermal Design of Heat Exchangers using Adobe Connect Software

Enrollment in this mode of instruction was limited to two students as mentioned in the previous section. Due to the small number of students enrolled through Adobe Connect, it was easy to reschedule them for different class meeting times from the extension IVC instruction. Before enrollments all main campus students were advised that they have to come to campus for presentation of their project, midterm and final exams.

Adobe Connect is another web based software, like DimDim. It has many similar features for presentations and a few additional improvements (in the licensed version), such as tech support, recording capabilities, better audio setup and a more intuitive interface. Similar to DimDim, Adobe Connect allows for file sharing, chatting, screen sharing and has an expandable whiteboard. The program itself cost approximately $1,500 in set up fees and licensing for a year, with a yearly renewal subscription of about $700. The subscription provided 10 teacher accounts, which could be used simultaneously.

A computer, internet access, and Adobe Connect link were needed for any student anywhere in the world to attend. The difference between Adobe Connect and DimDim is that DimDim was password protected, which created an entry barrier to the course. Adobe Connect can be configured to be simply shared through distributing a link to the meeting space. Not requiring a password from students eliminated one barrier to entry of having to set up student accounts and remembering login names and passwords. Adobe Connect had three other clear advantages over DimDim:

- Because the system was more stable, there were no unexpected downtimes, or major technical difficulties.
- Even though Adobe Connect was not password protected, the instructor could eliminate complete access at times.
- There were different designs for the display layout, where the instructor could see the students, on part of the display, or all display. Figure 1 shows a display of Adobe Connect: the board, instructor video, and students' live videos, and chat area. DimDim did not allow multiple webcam displays.

The instructor and students could write on a virtual white board in either DimDim or Adobe Connect, using a tablet and handwriting recognition pen. Also the instructor or the students could give Power Point presentations. Unfortunately during Power Point presentations, the instructor and students could not see each other, so body language was not communicated. To compensate for this, the instructor continued checking in with the students about possible technical difficulties. This interrupted the flow of instruction. If the instructor had the use of a second screen, one screen could be used for displaying the Power Point presentation, alongside with a webcam view of the students on the second screen.

An autofocus HD 1080p lens, webcam was used for instructing with Adobe Connect, partially seen in the top middle of figure 1. It has a clip flexible base, and the capability to focus and enlarge pictures or demos, thus helping the instructor to use the webcam as a document camera. Though it should be noted that when pointing to items from the textbook, the instructor needed

some practice time to get accustomed to the reversed pictures and reading upside down from the textbook, if that was ever needed.

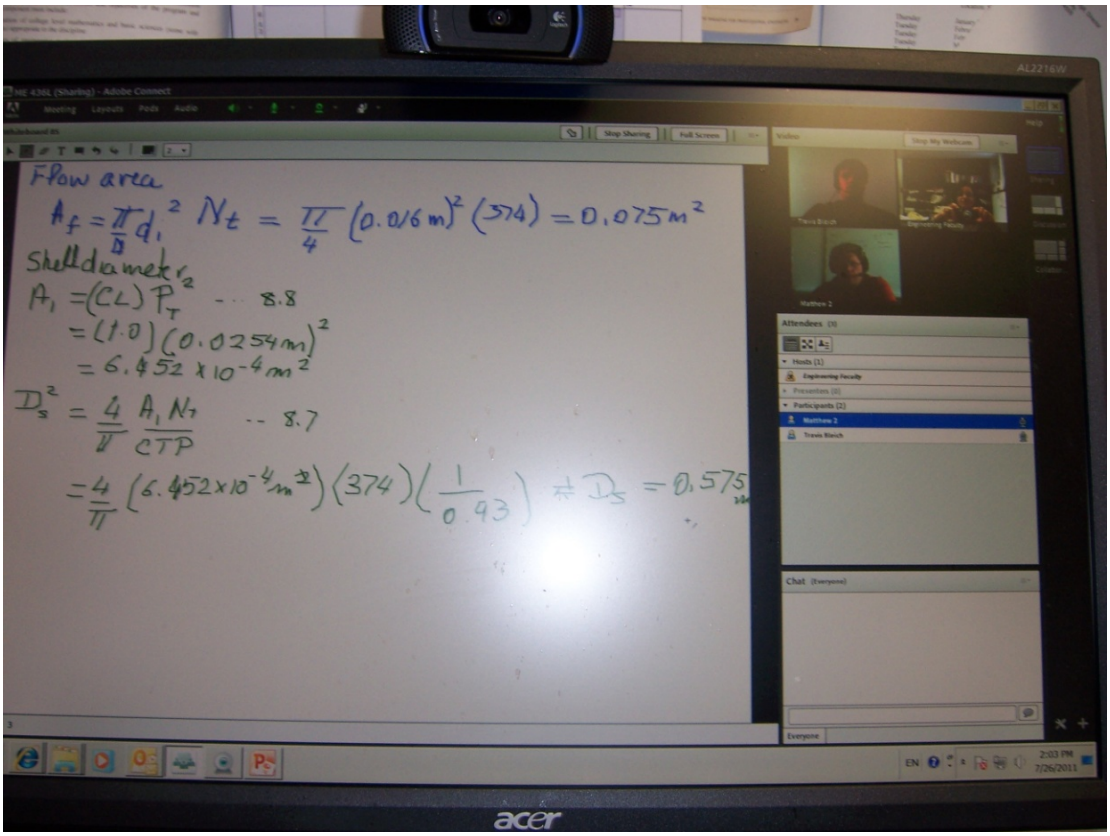

Figure 1: Adobe Connect board, instructor and participants' live video, and side chats.

Case 3: Thermal Design of Heat Exchangers using Interactive Video Conferencing (IVC)

The initial cost of the IVC equipment was high. Interactive Video Conferencing can be integrated into the distance education program with minimal adaptation to the curriculum and course and is designed to support two-way video and audio communication between limited locations. The system used had two channels with a presumed ability to connect up to four computers in distant locations, but was best used between two locations. With three connections the screen was split in two, and with four connections the screen splits into four, thus the size of the instructor location and extension location are each one fourth the screen. Most IVC systems utilize compressed digital video for the transmission of motion images over data networks. The video compression process decreases the amount of data transmitted over the lines by transmitting only the changes in the picture. Unlike watching movies or TV, IVC does not give continuous movement, and animation is distorted. Other types of equipment, such as television monitors, microphone, and tracking camera, are needed to make IVC successful. Figure 2, below shows the picture of IVC from main campus, showing the room in the extension campus on one monitor, the tracking camera, and the second monitor showing the Power Point presentation. It should be noted that both Extension and Main campus were small videoconferencing rooms, where students sat around a conference table. IVC allows real time visual contact between students and the instructor or among students at both sites. That was

particularly helpful with the final presentations of the projects where students at both locations had a chance to present their projects. Though the compressed images, and the way both classrooms were configured made it difficult to fully critique the presenters, and give them valuable feed back comparable to that given in a face-to-face set classrooms. In face-to-face classroom there is an instructor station, and free space for students to move next to the projection screen or the instructor station, unlike the videoconferencing room where student locations are set by the location of the camera, space is limited and students had to either sit down or bend to reach the computer key. Also the delayed transmission made it difficult to notice body language, and any subtle movements of the presenter.

Figure 2: Video Conferencing between Main campus and the extension.

At the start of lecturing with IVC, there were many problems. The first of these problems was connectivity. As mentioned earlier, the extra two connections to the two available channels on the IVC system, limited the available bandwidth. As the result of overloading the system with, the viewing portion for the extension students was reduced to one fourth the monitor. Consequently the Information Technology department advised not to connect any other equipment to the system. This included a document camera, a tablet and handwriting recognition pen. Instead, since the extension students had control over the tracking camera, they were able to focus on the physical classroom whiteboard, which the instructor used. Combining old with new technologies, the instructor used an old transparency projector to project images on the

classroom whiteboard. Varying the equipment used in class from Power Point to board to transparency projector seemed to retain more attention.

The Extension campus had a technician who assisted the students in setting up or monitoring the videoconference. However, the instructor did not have that support, considering that the course was offered in the evening, there was no technology help available. This became especially problematic when connectivity was lost twice during class time. The issue of lost connectivity was discussed with the Dean of Engineering. Consequently, the Dean of Engineering made sure that IVC distance learning courses that were offered the following semesters had a technician assigned, though that increases the expense of offering IVC distance learning.

Advantages of Interactive Video Conferencing:

- Establishes a visual connection between main campus and extension campus students
- Students at both sites can see and hear each other in real time enabling interaction and increase in understanding and active participation.
- Photos, computer images, graphics, text, and other varieties of presentation are possible to put up on the screen for all to see helping to clarify concepts. This capability is also an advantage with Adobe Connect.

Integration of Thermal Design of Heat Exchangers with Learning Management System (LMS)

Learning Management System (LMS) is a server-based system that is designed to manage learning content and learner interactions in an asynchronous manner, meaning that unlike the previous synchronous tools, all users do not have to be online at the same time to interact with one another. The LMS enables the learning content to be available online, allowing students to view and interact with learning materials through a web browser on essentially any computer—with any operating system—or even on a mobile device with browsing capability – on their own time. The LMS system we used is Moodle.

Moodle was used with both IVC and Adobe Connect instruction. Homework problems were posted on Moodle. Distance taught students, IVC and Adobe Connect, submitted their homework solutions through Moodle, then the graded homework was uploaded back on Moodle for each student to view his/her solution privately. What is unique about Thermal Design of Heat Exchanger homework problems is that each problem is a design in itself, takes numerous pages for solution and up to 20 hours to solve the homework. Each student came up with a completely different design for each problem. The instructor followed each student's solution and graded it using Adobe Acrobat features. The relatively small number of students involved in the course made the time consumed in grading reasonable. Some advantages of Moodle is that it kept records of the time the homework was submitted, the original homework submitted by the student, and the feedback and graded homework. Grades were recorded on Moodle, so students were able to see their grades instantly and any time throughout the course, after they were added to the grade book. Also, notes, handouts and pictures of different types of heat exchangers were posted on Moodle for all students.

Comparison between the Three Modes of Instruction

The total number of students attending instruction through Adobe Connect was 2, students attending through IVC were five, and one student attend from main campus face-to-face. The face-to-face student elected to attend with the IVC class as the class time was more convenient for him. The numbers are not enough to make a reliable conclusion about the results and observations of the instructor.

The face-to-face student had the highest achievement in the class, and best understanding of the subject. It is not clear if that achievement is due to the face-to-face instruction, or the fact that the face-to-face student did not have to work or take other classes, or because that student asked questions, or because the student was motivated. The instructor announced and made herself available half an hour earlier than the start of the IVC class, and was willing to answer questions after class. Not a single IVC student made use of that offer. Though, when the face-to-face student asked a question after a class, one of the IVC students stayed longer to hear the response. Another, IVC student always went the extra mile for every assignment given, and that student performed much better than the rest of the IVC students. The performance of the rest of the IVC students was average. This could be attributed to their work schedules and obligations. The two Adobe Connect students performed well though the instructor, having taught them before, expected an even better performance. The good but slightly lower than expected performance from the Adobe Connect students can be attributed to work schedules, or to inability to see the instructor at all times and lack of communication through body language. Also questions from Adobe Connect students were only during interactive broadcasting.

Students who physically met during class (IVC extension) were able to cooperate better on their projects than those who had to communicate online.

Recommendations for Preparing an Interactive Live Distance Learning Class

Establish class expectations, usually a clear syllabus, will help, but it is recommended to spend sometime the first class meeting to go over the syllabus, since some students never read the syllabus.

When designing instruction to be delivered to distance locations, the instructor should focus attention on all students, not just those at the main campus. Lessons should incorporate a variety of activities for all students at the various sites. Encourage dialogue by asking questions and noting body language, when possible. Reduce distractions, by incorporating a policy for laptops, and cell phones. The instructor for these courses does not allow digital equipment in class except for approved calculators.

When preparing class visuals, it is advisable to avoid small fonts and light colors because they do not show up well over the monitors. Pictures and schematics, with different colors will also assist in maintaining student interest and attention.

Summary of Challenges and Solutions

- Dissatisfaction of Main Campus students, with a three hour class once a week in the evening. *Solution:* Hold main campus classes during the day, twice or three class meetings a week (see survey of student in table I above and student comments).
- DimDim is non reliable, it went out of service during scheduled class times. *Solution:* Adobe Connect license has been acquired, and a web conferencing system (IVC) was purchased.
- Bad quality sound and echo. *Solution:* Headsets for all users.
- Inability of the instructor to move away from the podium. *Solution:* use of a wireless microphone and headset.
- **Engineering Analysis** does not fit on DimDim's or Adobe Connect white board. *Solution:* Wide camera on the classroom board, with IVC
- Document camera display was not able to transmit through IVC, DimDim, or Adobe Connect. *Solution:* use a wide camera with Adobe Connect or a wide camera for IVC. We also plan to experiment with connecting a smart board to the IVC system and expanding the bandwidth through a bridge rather than point to point channels.
- Delayed transmission, continues to be a problem for all systems DimDim, Adobe Connect and IVC
- Unless a strong effort is made by the instructor, students not located with the instructor may remain uninvolved in the course
- Not every student can handle interactive distance learning. The student must be organized, have good time management skills, have acquired good study skills, self-motivated, and not shy about asking questions.
- It should be noted that observing the body language with DimDim was not possible, while with Adobe Connect was possible at times, but not possible while using the Power Point. IVC had a delayed transmission that made it difficult to observe body language, bottom line the best method so far to observe body language is through face-to-face instruction.
- Extensive amount of e-mail, most of which is already posted clearly in the syllabus on the web. *Solution:* Future distance teaching classes, the instructor intends to use the web's discussion board and refrain from answering e-mail except for clarifying concepts, related to topics covered in class or homework. That policy will be clearly stated in the syllabus defining an appropriate e-mail.

Unresolved problems:

- Technology and integrity of exams: Unless exams are taken under the supervision of the instructor there is no guarantee of the integrity of the exam, particularly with the current high technological advances in cell phone technology.
- Videoconferencing rooms are not the best setting for taking exams.
- Distance learning and integrity of exams: There is no guarantee that the person taking the exam is the same person enrolled for the class. Unless a video camera is being used.

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