Distance Learning Pilot: Physics and Mathematics
A Two Part Session

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Distance Learning Team
National Technical Institute for the Deaf/Rochester School for the Deaf
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Background: Vincent A. Daniele

In the spring of year 2000 administrators from the Rochester School for the Deaf (RSD) approached the National Technical Institute for the Deaf (NTID) regarding the potential for having a group of RSD students take college-level science or mathematics in a distance learning format during academic year 2000-2001. Because NTID did not have any science or mathematics courses packaged in distance learning form, invitations were extended to NTID faculty in the Department of Science and Mathematics to determine if anyone might be interested in participating in a distance learning experience. Two individuals from within the department, Victoria Robinson and Joan Carr, volunteered to investigate the possibility of providing distance instruction in physics and mathematics, respectively

By the end of academic year 1999-2000, a team of individuals from NTID and RSD was established to explore what might be delivered to the RSD students. Although several members of the NTID/RSD Distance Learning Team are part of the panel gathered for this symposium, the complete team was actually a much larger group than you see here today. It included administrators, teaching faculty, a researcher, and technical and instructional support staff from both NTID and RSD. The team decided to pilot short units in physics and mathematics dealing with topics taken from the NTID curriculum. Live videoconferencing was selected as the primary method of teacher-student interaction. The lessons would be presented during late fall and winter of academic year 2000-2001. Six RSD students would be involved in the physics instruction and five would participate in the mathematics portion.

During the summer of 2000 two individuals from the Texas School for the Deaf, Denise Hazlewood and Dawn Kidd, provided their perspective and expertise regarding the use of videoconferencing. Their assistance was invaluable to the NTID effort.

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We will now present perspectives from members of the Distance Learning Team. Although all of us were quite positive about the experience, you will discern slight differences in opinion regarding the effectiveness of the techniques and components used to deliver the instruction.

Technical Aspects, NTID: Camille Aidala

Videoconferencing is the ability for two or more people at different locations to see and/or hear each other at the same time, sometimes even sharing computer applications for collaboration. At NTID, videoconferencing can be accessed from a variety of locations throughout the LBJ building to accommodate different size audiences. Over the past several years, NTID has been involved in a series of videoconferencing activities including formal instruction, connection with guest speakers and experts, multi-school project collaboration, professional development workshops, meetings and international events.

In support of these activities, a team of technical and instructional staff is assembled to facilitate videoconferencing activities. This group of individuals is responsible for scheduling videoconferences, providing technical support, and training faculty and staff regarding the potential uses of videoconferencing to support instruction of deaf students.

As Instructional Developer for the RSD/NTID Distance Learning Team, my main focus was to foster awareness and skill development by faculty regarding videoconferencing capabilities in support of educational and communication goals. I was also responsible for coordinating the technical support team comprised of members of NTID's Instructional Television Services Department. Without their resources and expertise, this project would not have gotten off the ground.

NTID Videoconferencing Setup

Equipment

NTID's videoconferencing system consists of a 24 channel T-1 Line with transmission speeds ranging from 56-1536 Kbytes. Besides the standard camera, monitors, and microphones required for videoconferencing, additional equipment includes a document camera, PC, VCR, split screen and real time captioning capability, two way taping, and a plethora of additional software such as Net Meeting and Microsoft Office. The math and physics classes each required use of additional hardware and software, such as digitizing tablets, whiteboards, and hookup to a TI calculator.

Rooms

The math and physics classes also required the use of different classroom configurations to deliver instruction. Physics classes were conducted from NTID's "Smart Classroom", a room large enough to accommodate a very mobile instructor, a 6 foot table used for physics experiments, computers for simulations and digitizing tablets, and a whiteboard and document camera used to support the scientific problem-solving process. The math classes were conducted from NTID's Sprint Room, a small room capable of accommodating the instructor and the director who controlled the cameras.

Technical Support and Instructional Objectives

As mentioned earlier, NTID's Department of Television Services played a major role in supporting this project. Their responsibility was to collaborate with the faculty to deliver instruction to RSD so that the "technical" aspects of videoconferencing were in the background, and the "instructional" objectives took priority. Examples of technical questions that surfaced were: What can I cover with this camera? How wide does the camera shot have to be to cover the physics experiment, and still be clear to the audience? How tight does the close up need to be for signing? Given the variety of different video signals for the audience to watch, would real time captioning be a help or a hindrance to the instruction? And, most importantly, how can we support this individual's teaching style?

Making these decisions was no easy feat. Additional cameras were installed, and a director was assigned to both projects and worked with the faculty to control what the audience saw during each class. The faculty also scheduled rehearsals with the technical support team to practice using the videoconferencing system in preparation for the actual classes.

During the classes, with direction from the instructor, the director controlled camera angles, and switched among video sources such as the computer, TI screen, whiteboard, and the document camera. Each of these "sources" needed to be managed in a seamless way to support the instructor as she presented content. Naturally, no signing could occur as students viewed output from different video sources, which made the communication a bit stilted.

For the physics classes, the director was remotely located in a master control room and managed all video shots from there. Communication between the instructor and director was two way. The instructor communicated with the director indicating when she needed the camera signal switched from one source to another, and the director communicated with the instructor via the technical support team located in the Smart Classroom. For the math classes, the director was located in the same room as the instructor, thus making communication between them a bit more manageable. All classes were recorded at both sites for students who were absent, allowing them to review the videotapes in preparation for their next class.

One major challenge for this project was aligning instructional goals with the technical realities of teaching via a videoconferencing system, and its impact upon the communication and instructional process.

Rhonda Parrish: Technical Aspects, RSD

The Distance Learning Pilot Project afforded RSD staff and students the opportunity to explore the potential use of videoconferencing. Although we were confident that we could manage the computer component of the project, we were less sure of our competence with videoconferencing. The project was the perfect opportunity for us to take on this new challenge.

During early planning for the project, RSD staff were still investigating videoconferencing equipment and were not close to deciding what kind of equipment would best meet our needs, nor what funding source might be used to purchase equipment. Attendance at a national conference focusing on videoconferencing use in schools for the deaf, whet our appetite for the possibilities

videoconferencing might afford our students. The conference also made it possible to see several of the products currently on the market.

ISDN lines were installed and videoconferencing equipment was delivered to RSD approximately one month before the first class was to meet. Although the vendor provided a training session, and we had made a few test connections to NTID, RSD staff and students were literally neophytes when we sat eagerly in front of our camera on that first day of physics class.

We were fortunate to have the opportunity to collaborate with a partner who has considerably more experience. NTID staff was extremely helpful in getting us started and providing support along the way. As the recipients of instruction, (rather than the providers) the technology demands on the RSD side were considerably less than those placed upon NTID. Our major challenge was to make communication natural and spontaneous. When all six students were in view, it was not possible to clearly see their signed communication. When a student wished to speak, or was questioned by the instructor, we zoomed in on that student using a preset locator. Although the preset allowed for quick repositioning of the camera, it was not instantaneous. Student had to learn to wait until the camera was repositioned before beginning to speak. The necessity to wait for this repositioning of the camera limited natural, spontaneous communication. As the project progressed students became more comfortable with the procedure and communication was less awkward.

A second challenge was to meet the needs of students who were absent from classes. For each class, videotapes were made of both the NTID and RSD sites. This meant that there were two separate videotapes, one of the instructor at the NTID location, and one of the students at RSD. If an RSD student missed the class, they could review the instructor-led NTID videotape before their next class session. However, there was not always an opportunity for students to view the physics videotape because of scheduling conflicts. In an ongoing, full semester course there would likely be more flexibility to allow for students to make up work they missed.

In addition to the live video class sessions, students in the physics class worked on computer simulations and wrote lab reports. The use of graphics tablets made it possible for students to submit drawings or formulas. The computer aspect of the project ran smoothly and the only challenge was in assuring student access during class times and times when they wished to do independent work for the project.

Overall, participation in the pilot project was a positive experience for staff and students. The necessity to learn about a new technology as it was being employed provided us with the motivation to take on this challenge.

Physics Pilot: Vicki Robinson

The physics project was conducted during eight, eighty-minute blocks of time. Four were used for instruction, and four were used by the students for doing associated assignments. The students were mostly the same group of students who participated in the mathematics project; a group of six intelligent and motivated students. In fact, these students' skills were such that much of the success of the physics project must be laid at their feet. With a less able group of students, the outcomes might not have been as positive as they were. None had any prior experience with physics, although all had completed the requirements in science for a (New York State) Regent's diploma.

The students were supported by Bob Gellner, the high school science teacher at RSD who was working with this project.

Structure of the Classes

The lessons were single-concept lessons, meant to be self-contained demonstration/lectures about specific physics phenomena. There was an introductory lesson to familiarize the students with the various technologies, and then three content-centered lessons. The concepts introduced were momentum, pendulums, accelerated vs. uniform motion and Hooke's Law. The presenting instructor at NTID showed a demonstration of the phenomenon, and conducted a discussion with the students over the videoconferencing link. The students often were given a short group activity, doing a brief qualitative analysis of the phenomenon, to help alleviate visual fatigue and to analyze on-the-spot comprehension. A five-minute break was also provided about halfway through each class session for the same reason.

The subsequent 80-minute science period, typically two or three days later, was spent doing homework on specially equipped computers.

Class Materials

The NTID instructor created a web site for the class. The site enabled the students to send email to either instructor (either the NTID instructor or the on-site RSD instructor), and contained lab instructions and additional instructional material.

Additional Technology

One difficulty of conducting a lab science in a distance-learning format is the need to provide students with hands-on lab experiences. There is no guarantee that students at the remote site will have access to any physics lab equipment at all, much less the same equipment that the presenting teacher is using to demonstrate concepts. This difficulty was handled using simulation software called Interactive Physics, by MSC Software. Interactive Physics allowed the presenting teacher to model the demonstrations that the students had seen during the videoconference. Students were able to vary the parameters of the demonstration, and built-in meters provided measurements of salient variables. This software gives students the ability to investigate "what if..." questions, freeze the action, run it in slow motion, or step through it frame-by-frame, forwards and backwards, to determine the effects of parameter changes.

One of the major barriers to electronic homework submission in the sciences has long been the need to include sketches and equation solutions. Drawing and paint programs can be cumbersome and difficult to use, and typing out formulas and equation solutions is tedious and error-prone. Six of the student computers at RSD were equipped with Wacom Graphire tablets, low-cost digitizing tablets with software enabling students to draw sketches, complete math work and draw tables with an electronic pen. Each student produced lab reports with a word processing program, but they also were able to attach their math work and sketches as a large graphic file. These were mailed to the NTID instructor, who used a tablet to grade this work. The graded lab report was then e-mailed back to the student.

The students were very enthusiastic about both the software and the digitizing tablets. They liked the tablets because they came with art software that allows a great deal of creativity, and they had a wonderful time experimenting with it. Regarding the software, the students particularly liked the ease with which changes could be made to an experimental setup and measurements read from the meters. One student specifically liked the precision of the simulations; this may be a drawback to the use of such software, since real-life measurements have a certain predictable lack of precision.

Distance Learning and Deaf Students

The students were generally positive about the physics experience. Pre-test/post-test results showed that learning of physics concepts had occurred, although the students showed a generally good understanding of the concepts in the pretest. Pretest scores were around 60% -80%, while posttest scores were all 100%.

Difficulties that we encountered were mostly due to the videoconferencing modality; waiting for the camera to zoom in on a student was tedious, and made the already stately pace of communication even more ponderous. However, the students bore it with good grace, and once the new procedures were familiar, they ceased to be a problem. Use of the document camera for close-up views of equipment, or switching to the computer screen to illustrate a simulation required preparation, because there was no "voice-over". Students had to be told what they'd be shown and what to look for, then reminded afterwards what they'd seen. This did not cause a great deal of confusion. With adequate preparation, the students were able to find salient aspects and comprehend what they were seeing. This might, however, be a harder thing to accomplish with a less-able student group.

The anticipated feeling of disconnect between the presenting instructor at NTID and students was less of a problem than expected. Part of this can be attributed to the teacher's having traveled to RSD for a brief meeting with the students before the first class, and partly to class-teacher personality dynamics. The teacher is naturally outgoing and informal, and students were involved and interested, so there was little stiffness or hesitation in any of the interactions. Even over a videoconferencing link, the technology faded away after a while and the lesson felt much like face-to-face teaching. This is a very subjective impression, however; with a different class or teacher, the technology may be felt to be much more bothersome.

Physics Afterthoughts

Generally speaking, the physics portion of the distance-learning project was highly successful. One must realize, however, that part of the success was due to its short run (only four lessons) and the concomitant ability to present interesting and fun topics during these lessons, without some of the less exciting but equally important emphasis on problem-solving techniques and creating mental links between topics. The students were outstanding; a group of less-able students might have had a great deal more trouble. As it was, the homework-processing time was not adequate for the students to complete their lab reports in all cases, and the aid of the on-site teacher was very important both for technical support and understanding of the concepts. Students participating in this form of instructional delivery would need to have free access to properly-equipped computers for completion of their work, and knowledgeable help would have to be available. The amount of time that went into lesson preparation was enormous, as well; the presenting institution would have to be able to provide the preparation time and equipment support up-front.

Mathematics Pilot: Joan Carr and Patti Spiecker

Overview

A series of five videoconferencing lessons were done. At the Rochester School for the Deaf (RSD) site there were 5 students, their teacher, and one professional who provided technical support. The students were all high achieving, college-bound seniors. Four were at the pre-calculus level, while one was a year behind. At the NTID presentation site, there was one instructor who had no previous experience with distance learning, a director who controlled the camera, support from a number of other technical folks, as well as help from a professional who set up and managed a temporary web site.

Structure of the Classes

The five math lessons took place during regularly scheduled 80-minute math blocks for 2 weeks. The structure of each class was roughly the same: Students at RSD printed out materials for their class from the internet (see below), got a graphing calculator, and then sat down in front of the camera. The camera was controlled remotely by their teacher who used presets for close-ups and wide angle shots. When all students were ready, the presenting instructor began a participatory lecture which included demonstrations with the calculator, written work on a white board, and questions to and from students. Each lecture lasted about 30-40 minutes and was followed by an assignment which students completed while the instructor was still live and available for help. It should be noted that the white board, while actually a pale gray, should have been a darker gray to avoid glare and provide clearer viewing.

Class Materials

A very simple web site was set up from which students could download each class lesson or "lab", homework assignment, and an abbreviated homework submission form, which had been posted in PDF format. The abbreviated submission form facilitated easy and inexpensive faxing of answers to the presenting instructor. Students were also able to e-mail the instructor from that website, though none chose to do so.

Additional Technology Used

The purpose of the five lessons was for students to learn to use some of the graphing capabilities of the Texas Instruments TI-83 Plus Graphing Calculator to do mathematics. Although the students had used these calculators earlier in the year, they had not yet used its graphing features. Also, the Texas Instruments TI-Presenter was used. This piece of equipment fed into the video output and enabled the instructor's graphing calculator window to be displayed full-sized to the students at RSD. A document camera was also used by the presenting instructor once in a while to show summary information which had been prepared ahead of time. During this experience we did not use a split screen since the room where the lessons were produced didn't have that capability. This meant that there could be no signed communication from the instructor while the TI-Presenter or document camera was being used.

One very important piece of old technology was the use of videotapes that were made of the lessons. Both sites were taped, but separately. Students did miss an occasional class and were able to watch the instructor's part of the lesson, even though they could not simultaneously view the RSD student tape. Students who had to watch these somewhat incomplete versions of the lesson felt they were adequate to catch them up on what they had missed. However, it should be noted that students could easily obtain same day tapes because of the proximity of the two schools, a convenience, which would not normally exist. Another piece of technology that was used was the fax machine. Students faxed their completed assignments to the presenting instructor, which she then corrected and faxed back to them.

Only one technology break down occurred. The computer which controlled the camera at the RIT site crashed and that one videoconference had to be cancelled. Luckily, the teacher at the RSD site was skilled in the use of the calculator and was able to jump in and teach the class herself.

Distance Learning and Deaf Students

The students were quite positive about this mathematics distance learning experience. By the end of two weeks, the students were able to demonstrate how to approach a variety of mathematical problems using a graphing calculator. While all five students received 0% on the five question multiple choice pre-test, they showed significant gains on the post test. There were two students who got 60% and three who got 80% on the post-test. The fact that multiple choice questions were used should not be interpreted as an endorsement of that format. It was simply a convenient means of obtaining a speedy and rough assessment of student learning.

Communication between the presenting NTID teacher and students, while not perfect, was reasonably smooth. Effective communication is essential in any type of learning environment, and for deaf students using American Sign Language, the visual aspects of communication are critical. The students felt that the first distance learning lecture was a little too long, resulting in some tired eyes. Beginning with the second class, the students had to use their calculators more regularly throughout the lecture, giving their eyes a needed break from the stress of staring at the monitor. Another minor difficulty in communication was the wait time needed to focus the camera on students who wanted to ask a question. This wouldn't have been necessary for a class of hearing students, but was essential in order for the presenting teacher to see the student questions, answers and comments.

The presenting instructor felt less connected to the students than she would have in an actual classroom. Communication seemed less spontaneous perhaps because of distance to the camera and the need to zoom in to see student questions. In traditional classes, eye contact is an effective way to keep students engaged. Unfortunately it was hard to maintain eye contact with students because of the camera and monitor placement. While the presenting instructor was signing and looking at the student TV monitor, she did not seem to be making eye contact with the students. Conversely, while the presenting instructor looked directly at the camera, she seemed to be making eye contact with the students, but was not able to monitor the students except peripherally. Further, the presenting instructor was less able to take advantage of spontaneous student interactions than she would have been in a regular class. While the camera was zoomed in on a student, she may have missed seeing comments and side conversations from other students that might have provided

insights for the whole class. And obviously she couldn't look over the students' shoulders as they worked on their assignments.

From the point of view of the RSD (receiving site) instructor, there were a number of positive aspects to this particular experiment. Having students perform calculator activities during the lecture broke up what could have been visually stressful or monotonous. The presenting instructor stayed connected to the receiving site while students worked on their assignments, and the receiving site instructor tried to stay in the background. Thus students needed to express their questions to the presenting teacher; a process which probably reinforced newly learned technical vocabulary. In addition, the RSD students began to depend more on each other while working on problems instead of just asking their own teacher for help. In the view of the receiving site instructor, the production of the videotapes was essential and effective. Students who missed class due to illness or a conflict were able to watch a tape to catch up. The students who did so said that the tapes were clear and were able to complete their assignments. On the negative side of the ledger is her observation that during the videoconferencing, student communication seemed less spontaneous than in her regular class, perhaps because of the presence of the camera, or perhaps because of the nature of distance learning.

Conclusion: Vincent A. Daniele

Several aspects of the NTID/RSD distance learning project were positive. The RSD students approached the material with mature attitudes, and their enthusiastic response to the lessons was encouraging. Indeed, I suspect this experience was productive in large part because of the students involved. They are intelligent, motivated young people. As the administrator with responsibility for monitoring instruction in the Department of Science and Mathematics, I can state that I judged the communication between the NTID teachers and the RSD students to be reasonably clear and effective. Moreover, students did well on the post-tests. In my view the pace of the instruction was close to, but probably a bit slower than, what one would encounter in a self-contained classroom.

Conference participants should be mindful that our department is probably a long way from offering complete courses in distance learning formats, particularly if videoconferencing were to be a major component. Many of the problems and questions we would face in regard to use of videoconferencing would be common to any institution wishing to use this technology. So, for example, because videoconferencing is a synchronous activity, coordinating teaching schedules, calendars, and time zone constraints with distant sites over an extended academic period presents issues not easily resolved. In fact, even student absences seem to have the potential for a significant impact if a videoconferencing format is to be used, since making up work may not be readily accomplished. Likewise, the costs involved in any future distance learning efforts would need to be carefully considered. Because of the technology involved and the size of our joint NTID/RSD team, the current pilot was a relatively expensive method of delivering instruction. We also need to acknowledge that the faculty and staff at RSD were able to provide strong instructional and technical expertise. These realities prompt questions about the wisdom of attempting videoconferencing without similar support.

The professional literature is replete with cautions that have been sounded in an effort to help educators understand the benefits and limitations of different forms of distance learning. Any of the

standard issues enumerated would certainly be something we at NTID need to consider. However, there are undoubtedly additional concerns for distance learning programs intended to serve deaf students.

In particular, any program attempting to provide distance learning to deaf students needs to consider these points and questions:

- Videoconferencing simultaneously with more than one distant site is probably unrealistic because of the communication logistics involved. It would appear to be very difficult and time consuming to monitor and coordinate communication between two or more distant sites at the same time.

- In many situations, showing a computer screen or calculator image via videoconferencing precludes doing a "voice over," which is something that would occur quite naturally if the students in the audience were hearing.

- If the deaf students involved are not strong users of ASL, can or should videoconferences be captioned?

- How will distance learning instructors be selected? A combination of communication effectiveness and content expertise is essential.

- What characteristics of deaf students might have an impact on the appropriate use of distance leaning? How important are student age, maturity, and academic match?

- What benefits and limitations would distance learning formats other than videoconferencing present to teachers and students?

- If college distance learning courses are intended to serve high school students, one should probably ask if the students would be better served by a challenging local program, even if interpreters would be needed.

Unquestionably, distance learning is increasingly recognized as a valid method of delivering instruction. Equally certain is the fact that educational tradeoffs and compromises will be involved when distance learning is employed. Although there was a great deal that was positive about our joint NTID/RSD experience, the lessons were different from what typically transpires during self-contained classes at NTID. All of us interested in effective teaching of deaf students need to ask what circumstances make the educational compromises required by distance learning worthwhile.

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