Science + Education = Science Education

A study funded by the **P-12 Scholars Program** at OSU and the National Science Foundation (NSF) Science and Technology **Center for the Remote Sensing of Ice Sheets** (CReSIS)

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Introduction

With support from the P-12 Scholars Program at The Ohio State University (OSU), a multi-use classroom, a Learning Center, was established in a science research facility on campus to pursue novel educational enrichment and assessment objectives. The development of the Learning Center enabled the pursuit of an objective that could not otherwise have been achieved. This pilot project was designed to provide a learning environment within which educators could gain skills in information and communications technologies (ICT) and within which the transfer of scientific and pedagogical knowledge between and among the participants could be assessed. Science graduate students, education graduate students, and high school teachers were recruited to participate in the study as they developed technology-enhanced lessons and presentations about cutting edge scientific research.

The Byrd Polar Research Center (BPRC) in Scott Hall was proposed as the ideal site for such a unique laboratory, where the types and amount of interaction among and between graduate students from the sciences and from education could also be observed and assessed. The principal advantage to participants was anticipated to be free access to modern technologies coupled with personalized instruction in their use. Students were also expected to benefit from opportunities to overhear and observe the delivery of information outside their chosen field of study.

Three primary target populations were invited to participate in the study:

1. Master's of Education (M.Ed.) students in the Mathematics Science and Technology (MSaT) program in OSU's School of Teaching and Learning, College of Education and Human Ecology, were invited to collaborate and learn while eating lunch;
2. Graduate students in the sciences with research appointments at BPRC; and
3. Teachers at the Metro High School, a nearby public school that serves 16 Franklin County districts in partnership with OSU and the Battelle Memorial Institute.

Study Design and Accomplishments

Over the 2006-07 academic year, a combination of support from the OSU P-12 Scholars Program and National Science Foundation (NSF) facilitated both hiring personnel and purchasing ICT to meet the science education and assessment objectives. The scope of the study is outlined below, followed by a timeline of specific accomplishments.

First, a graduate student seeking an advanced degree in science education was hired to assist students and teachers by demonstrating the utility of the ICT in lessons. This GRA position was funded entirely by the National Science Foundation's Science and Technology Center for the Remote Sensing of Ice Sheets (CReSIS). The student spent much of the first three weeks helping to convert the room from a scientific lab to a classroom. This involved moving equipment out, obtaining and cleaning furniture from OSU Surplus, and having the floor repaired and the room painted.

The ICT purchased for this study included both Mac and Windows laptop computers, SMART Boards with Airliners (wireless hand-held versions) and Sympodium (controlled from the lectern), two video cameras with tripods, the Camtasia Snag-it Bundle video capture software for Windows-based computers (the parallel to iMovie for Macs). The ICT and science equipment (e.g. Vernier probes with Go Link! software, Digital Blue USB microscopes, and Teaching Tanks) were made available beginning in AU quarter, 2006.

An Open House was held in the Learning Center on September 18, 2006. Faculty and staff members from the College of Education and the Departments of Geological Sciences, Geography, and Anthropology, as well as representatives from the PAST Foundation and the Metro School, were among the twenty-six people who attended. They were given a quick demonstration of the SMART Board, digital microscope, and probes, which were then left on to offer opportunities for individuals to explore the technologies.

Student participants for the knowledge transfer assessment were recruited via announcements in the BPRC newsletter and *OSU Today*, specific requests to the Principal Investigators of the BPRC and faculty members in the sciences, and communications and invitations to the Mathematics Science and Technology (MSaT) faculty of the College of Education and Human Ecology. The Principal and teaching staff at the Metro School were also specifically invited to participate in the study. Several follow-up phone calls and personal inquiries were made to enlist participants. We were informed that the Principal Investigators and/or faculty members were unable to require their students or advisees to participate. So we appealed to the graduate students directly. Most of the science graduate students thought it was a good idea and considered participating, but none did. Likewise, none of the teachers from the Metro School participated in the study.

The M.Ed. students who participated in the study came to the Learning Center individually or in small groups over the period of Autumn and Winter quarters. On the first visit, each M.Ed. student completed a pre-test of technological proficiency (self-report), after the necessary informed consent was obtained. A record of time spent in the Learning Center was maintained by the GRA. Qualitative assessment of learning was made via questionnaire and a follow-up phone interview (after the final quarter of participation) provided data about the subjects' subsequent use of the ICT. The delivery of instruction by the GRA was documented and the development of tutorials and instructional aids are represented within the time line (see below). One professor in the College of Education encouraged M.Ed. students to use the Learning Center to contribute to a total of ten hours of professional development experiences that were to be earned before the end of the second quarter of classes (WI quarter).

Timeline

Summer '06: Institutional Review Board approval received; Science Education Ph.D. student hired as GRA; cleared and repurposed the room; selected, purchased, and set up the ICT; continued interaction with MSaT and science faculty; demonstrations of the technology were provided to the new cohort of M.Ed. interns; modifications were made to the learning space; familiarity with features of ICT and the types of lesson enhancements that are possible was gained; and instructional materials and tutorials were prepared for independent use.

Autumn ’06: more tutorials and examples were developed; interaction with OSU faculty continued; an Open House was hosted; an intake survey of technological proficiency (pre-test) for subjects was developed and administered (individually); the research cohort was established and data collection began.

Winter ’07: interaction with OSU faculty continued; data collection continued; additional lessons and demonstrations were developed; a booth was hosted at the Science Education Council of Ohio annual conference in Dayton, OH; a presentation was made with the SMART Board representative at the Digital Union; a WI quarter BPRC seminar about the project was hosted. Note: The Learning Center was used as the site for a graduate seminar course (SES 780) and an undergraduate honors course (Anthro H201) this quarter. The SMART Board was used in both of these classes.

Spring ’07: additional support and collaborations were sought; a presentation was made at the National Science Teachers’ Association (NSTA) annual conference in St. Louis, MO; telephone interviews were conducted to conclude participation; the workspace and technologies were adapted for summer use (teacher workshop). The Learning Center was the site of another graduate seminar (Geogr. 820.01).

Summer ’07: interaction with OSU faculty continued; telephone interviews concluded thereby ending data collection; summative reports were developed and submitted; workspace was adapted for addition of 10 Mac computers to establish a local area network (LAN); a 2-week teacher workshop was hosted in the Learning Center.

Autumn, ’07: data entry and analysis continued; a summary report was prepared and presented at the School Science and Mathematics Association (SSMA) annual conference in Indianapolis, IN (Nov. 17, 2007); the final report to P-12 Scholars Program was completed; the Learning Center was prepared for another upgrade (polycom capability and new furniture). The Learning Center was the site of another graduate seminar taught by Dr. Mark.

Results

A total of 26 graduate students in the M.Ed. program enrolled in the study, along with one part-time student who was a regular substitute teacher for Columbus Public Schools. Fourteen of the subjects were women. Eight subjects visited the Learning Center once in Autumn quarter, and 19 others visited once during WI quarter to earn two hours of professional development credit. Only two students returned to the Learning Center for a second visit. A total of 22 students completed the study by spending time in the Learning Center acquainting themselves with the ICT, completing the questionnaires, and participating in a follow-up telephone interview. Of those interviewed, 5 were preservice mathematics teachers, 13 were preservice science teachers, 1 was seeking licensure for elementary grades, and 3 others did not identify themselves with a particular program.

It is noteworthy that the subjects were all students in the College of Education and Human Ecology. No students or faculty from the sciences fully participated in the study, and none of the teachers from the Metro School visited the Learning Center. However, four scientists (researchers or professors) from BPRC visited the Learning Center in 2006-07 to learn more about the ICT. A group of educators from the Columbus Zoo and Aquarium also visited the Learning Center to learn more about ICT. Subsequent to that visit, they purchased a SMART Board for their classroom building at the Zoo.

Dr. Mark used the SMART Board and videoconferencing when his classes met there to interact with a collaborator in Canada. He is also working with a graduate student who videotaped and is processing the footage to document and describe his fieldwork in Peru.

<u>Information Technology Self-Assessment (Pre-test)</u>

Twenty-seven students completed the self-assessment of technological proficiency. It consists of a questionnaire (Appendix A) with 30 items, distributed among 7 categories: computer systems, connecting and using peripherals, spreadsheets, communicating with others, problem solving, databases, and graphics and multimedia. Five of the subjects reported needing no help on any of the items; 17 reported needing help with up to 9 items; and 5 reported needing help with 10 or more items.

Five items were marked by 10 or more of the subjects:

2D: Routine care of peripheral equipment (clean filters, exchange bulbs, exchange toner cartridges, load paper, label and store cables).

3E: Customize formatting of charts or graphs created in a spreadsheet. Define and use built-in data functions of a spreadsheet, such as sort, filter, and find.

5C: Install new hardware and trouble-shoot.

6C: Design, create, and manipulate an original database.

7F: Demonstrate effective search strategies to locate and retrieve electronic [sic] information (e.g. use syntax and "Boolean logic operators and/or terms" correctly).

<u>Information gained from post-experience interviews</u>

<u>*Placements in schools*</u>

M.Ed. students in the MSAT program at OSU spend time as interns in area schools during each of three quarters of the academic year. Efforts are made to assure that students seeking licensure in math, science and/or technology education are able to have classroom experiences in both urban and suburban school settings, as well as at both the middle school and high school levels. Nine of the subjects were placed in urban schools for two of their three field experiences (quarters), and ten others were placed in suburban schools for two of their three quarters in the classroom. One subject was placed in urban schools for all three field experiences, and one was not assigned to a school in the third quarter. One subject was a substitute teacher for an urban district, and therefore, not subject to other school placements. Fifteen of the subjects had two placements at the high school level and one at the middle school level; while five subjects had the opposite experience of two middle school placements and one high school placement.

Access to Technology in Schools

Subjects were asked to classify their school placements as having ICT or lacking ICT (either/or). Thirty-six of the 62 classrooms used for placements were described as having technology, and 26 were described as lacking technology. If technologies were described as available but unused, the classroom was assigned as "having technology."

Disposition of the Cooperating Teacher Toward Technology

Forty of the 62 cooperating teachers were described as having a positive attitude toward the use of technology in the classroom, while 22 were described as being negative or indifferent. No criteria were offered to help the subjects define a positive or negative attitude, making this a completely subjective assessment.

Order of Preference for Technologies

The telephone interview included the following prompt:

> *"Of the technologies available at the Learning Center, rank the following, in order of your preference, as those you most wish to have in your classroom as you start your career as a teacher."*

Thirteen of the 22 subjects listed the SMART Board as their number one choice. All of the subjects placed the SMART Board (interactive white board) among their top three choices. The second most popular of the items listed was probes. Among them temperature, motion, and pH were the most frequently listed as first, second, and third choices, respectively. The item with the lowest average ranking was the video camera.

Reasons Given for not Having Access to an Interactive White Board

> *"If you did not have access to an interactive white board (e.g. SMART Board) at your school, what do you think are some of the underlying reasons for not having this technology?"*

Seventeen of the subjects listed "lack of funding" as the primary reason why their classrooms lacked interactive white boards. Following that choice, lack of knowledge and a variety of "other" reasons were listed, such as: "retrofitting an old room," "compatibility with wiring in an old school," "lack of tech support," "no one applied for a grant," and "scared of investing in faddish technology."

Interest in Learning More

> *"Which response below best describes your interest in learning more about the use of digital technologies in the classroom?"*

1 Uninterested 2 More or less Disinterested 3 Unsure 4 Somewhat Interested 5 Very Interested

Eleven of the subjects selected 5) “Very interested”; ten selected 4) “Somewhat Interested” and one selected 3) “Unsure.” In other words, 21 of the 22 subjects indicated that they were either very interested or somewhat interested in learning more about the use of digital technologies.

Factors that Influenced the Subjects’ Use of Digital Technologies This Year

The most frequently mentioned positive influence on the subjects’ use of digital technologies was the subject they taught (21 of 22 respondents). An additional 19 of 22 said that their university supervising teacher was also a positive influence. Sixteen of the 22 subjects indicated that their personal proficiency with technology was a positive factor in their use of digital technologies. More than half of the subjects also indicated that access to technology, their cooperating teacher (in their placement school), and other M.Ed. students were also factors that had a positive influence on their use of digital technologies.

Not surprisingly, the factor that was most frequently cited (13 of 22 subjects) as negatively influencing their use of digital technologies this school year was “time to spend”. Eight said that their cooperating teacher was a negative influence, and 8 also said that lack of access to the technologies was a negative influence.

Discussion

The study has distinct limitations, (such as sample size and lack of participation by science students); but it also provides useful information about the opinions and experiences of the preservice teachers who participated. The 27 subjects who began the study provided a self-assessment of their technological proficiency in the pre-test. This information showed a rather typical “bell curve” distribution, with 5 reporting no help needed (proficient in all areas), 17 indicated they needed help with up to 9 of the 30 items, and the remaining 5 reported needing help with 10 or more of the items.

One of the most commonly checked items where the subjects indicated that they needed help was routine care of peripheral equipment (such as changing bulbs, cleaning filters, exchanging toner cartridges, labeling and storing cables, etc.). Many of those tasks would be specific to the equipment or setting, and it is understandable that some of the preservice teachers indicated that they might need help with them.

Installation of new hardware and trouble-shooting was another area marked by 10 or more of the subjects. These tasks are often relegated to technical staff, and are also likely to be an indication of personal preference. Some people do not voluntarily install new hardware or troubleshoot when difficulties arise.

Perhaps the most interesting finding (for a group of math, science, and technology preservice teachers) was that 17 of 27 indicated their lack of confidence in customizing the formatting of charts or graphs in a spreadsheet application, or in defining and using some of the data functions (sort, filter, and find). Likewise, almost half of the group, 11 of 27, indicated that they needed help to demonstrate effective search strategies to locate and retrieve electronic

[sic] information (such as using syntax and "Boolean logic operators and/or terms" correctly). These findings may be areas worthy of further investigation among preservice teachers of any content area, since teachers are frequently encouraged to demonstrate and teach technology objectives embedded as authentic tasks within their content area.

While 13 of 27 also reported needing help with designing, creating, or manipulating an original database, it is possible that the term "database" was misunderstood. In future applications of this questionnaire, an example will be offered to ensure clarity.

Twenty-two students completed the entire research protocol, ending with a telephone interview that asked about their perceptions of technology use. More than half of the classrooms were described as having technology available for student use (36 of 62) and 40 of 62 teachers were described as having a positive attitude (or disposition) toward the use of technology in the classroom.

The subjects' preferences for digital technologies they would like to have as their teaching career begins were topped by the opportunities to use interactive white boards, followed by access to a variety of probes. These findings suggest further investigation may be warranted. What might help to explain the subjects' strong preference for interactive white boards?

Interestingly, a strong majority of the students (21 of 22) expressed "interest in learning more about the use of digital technologies in the classroom." Yet only two of the students came back to the Learning Center for additional opportunities to learn and receive personalized instruction. The factor that was most frequently stated as negatively influencing their use of technologies was "time to spend." This factor may explain their lack of additional participation in the Learning Center, but what other factors might also be involved?

Keep in mind that the primary objective of this study was to assess the transfer of scientific research and pedagogy between the unique user groups of the Learning Center--scientists and educators. However, lack of participation in the study by scientists and science graduate students essentially negated the possibility of achieving that objective. How can that lack of participation be explained?

Some unintended outcomes of the establishment of the Learning Center served to promote the inclusion of ICT in lesson development. The Learning Center has been the site of three OSU classes. In all three classes, the SMART Board was utilized throughout the quarter, guided by the GRA from this project and by the active participation of tech-savvy students in the classes. Note: The students in these classes were especially eager to use the technology when they gave their presentations.

There have been additional investments in technology for the Learning Center, beyond the initial list of ICT made available from the P-12 Scholars Project. A set of 10 Macs have been set up as a Local Area Network, complete with routers and the necessary wiring. A Lumens document camera was purchased, enabling users of the Learning Center to digitally capture three-dimensional objects (and documents). In addition, a set of audience response "clickers" was purchased with outside support and has been used with several of our outreach audiences.

A laminator and supplies were also purchased subsequent to the P-12 project start, and three Teaching Tanks were also donated to the Learning Center.

The Learning Center has also been used as the site for videoconferences hosted at the BPRC, and for outreach events with visiting groups of students and adults. The technologies of the Learning Center were also showcased during the teacher workshop that was offered in summer quarter in 2007. The teachers in that workshop represented 15 school districts in Central Ohio, some of whom were already familiar with SMART Board functions and lessons. The workshop participants were also given the opportunity to test the functions of the Lumens document camera, the USB digital microscope, and the probes.

There is strong interest among the M.Ed. students to learn more about the SMART Board technology. However, they reported very little use of SMART lessons due to the lack of interactive white boards in their school placements. The SMART Notebook software is a free download, and the clip art, graphing functions, and recording capacity can be done in a "display mode" as well as an interactive mode. In light of its availability and the visual advantages it offers, anticipated teacher use was higher than actual use by teachers. This might also be explored further in future studies.

Resources are being focused this year on the development of lessons for concepts found in the state academic content standards in science and mathematics that explicitly illustrate the value of ICT applications. Demonstration of the advantages of using ICT within standards-based lessons may encourage M.Ed. students to use them in their school placements, even if they are simply projected (not used with an interactive white board).

Similarly, efforts are being made to identify ICT-enhanced lessons that help to deliver difficult science concepts for college students. Perhaps demonstration of these lessons will increase the likelihood that faculty and/or their graduate students in the sciences, technology, engineering, and mathematics (STEM) will begin to incorporate ICT in their instruction.

While the participants in this study were unable to benefit from direct interaction with science researchers, there were other distinct positive outcomes. The primary positive outcome is increased awareness and use of ICT for the college classes taught in the Learning Center. The increased use of Scott Hall for educational purposes has a secondary positive outcome because it provides more public exposure to the scientific research at BPRC and to the roles of students in that research. Lastly, the ability to conduct and archive videoconferences is more and more in demand. In fact, the Learning Center is being fitted with state-of-the-art video conferencing equipment to enable a distance learning opportunity in SP quarter between OSU/BPRC and students in Beijing, China.

Lastly, the Learning Center is being used as the site of another pilot project. Funds made available by the Director of the BPRC and the BPRC Archival Program are being used to invest in the acquisition and digitization of historic images and other documents from the almost-50-year history of polar studies at OSU. These images and documents are being scanned in the Learning Center, and uploaded to the Media Manager website. In addition, with additional support from the Media Manager team and the Colleges of the Arts and

Sciences, the BPRC Media Manager project is contributing to the development of Version 2 of the Media Manager application.

The P-12 Scholars project provided the seed money for the development of a multi-use classroom that is equipped with an increasing variety of ICT options. Greater use of the classroom, and the growing list of available technologies in the Learning Center, both offer evidence that ICT is in greater demand than it was last year. Additional funding is being made available to equip the room for videoconferencing, and even more funding has been sought to upgrade the software and to provide powered tables (to reduce the necessity of cords). Mark and Landis were interviewed for the P-12 Scholars report as well as the OSU Partnerships document for 2006-07. A presentation about the project is scheduled in February for the annual conference of the Science Education Council of Ohio (SECO), and an article about the project is also being prepared for submission to professional journals.