AC 2010-1299: ONLINE TUTORING SUPPORT SERVICE FOR STEM

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Susan L. Miertschin is an Associate Professor in Computer Information Systems at the University of Houston. She began her career in higher education teaching applied mathematics for engineering technology students. She demonstrated consistent interest in the application of information and communication technologies to instruction. This interest plus demonstrated depth of knowledge of computer applications and systems caused her to change her teaching focus to computer information systems in 2000. Recently, she has completed graduate course work in the area of Medical Informatics in order to deepen and broaden her knowledge of a key application domain for information systems. She has taught both online and hybrid courses and is interested in enhancing the quality of online learning experiences.

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Susan Schroeder, M.S. has been employed by the University of Houston as Lecturer for 16 years. She teaches mathematics courses such as Applied Numerical Methods, Applications of Discrete Methods in Technology, and Merchandising Mathematics in hybrid and online formats. Ms. Schroeder is also the Program Manager of Instructional Support Services, a lab that provides student academic support and faculty instructional support. She understands that mathematics can be a difficult course for many students and continually challenges herself to excel as a communicator in the subject. She became interested in ways to interact with students in remote locations which led to the investigation of online tutoring. Currently, the Instructional Support Services Lab offers live tutoring with a web conferencing tool.

Online Tutoring Support Service for STEM

Introduction

Quantitative and computer intensive courses commonly found in STEM curricula are especially challenging for many students. When these courses are offered in online and hybrid formats, the challenge can become even greater. And yet, non-traditional course formats offer much in terms of making STEM degree programs widely available to diverse audiences. Due to this appeal, online and hybrid format courses are becoming more common. To support these initiatives, institutions of higher education are developing creative ways to effectively support students enrolled in nontraditional format STEM courses.

Students at the University of Houston who enrolled in specific courses already had the advantage of an Instructional Support Services Lab to support their course experiences, regardless of whether their enrollment was in traditional face-to-face format courses or non-traditional online and hybrid format courses. The ISS Lab, situated on campus within the College offering the courses, provides on-site tutoring, including tutoring for quantitative and computer-intensive courses, as well as general support for courses, such as on-site testing. With increasing popularity of non-traditional format courses, the need grew for a tutoring service that was easily accessible and effective for delivering tutoring for quantitative and computer-intensive content, regardless of location and time commitments. Thus, a system for delivering on-line tutoring for quantitative and computer-intensive courses was developed with the support of an institutional grant. In order to evaluate the effectiveness of the added service and to determine methods for improving it, development and implementation was monitored and evaluated using an action research approach. This paper reports the implementation experience, including the following components:

- A foundational basis for effectiveness of online tutoring through an overview of literature and online tutoring options,
- Background about the institutional infrastructure that enables the service,
- A presentation of the factors that must be considered in the implementation including general lessons learned, technological drivers of success, and preliminary data regarding student perceptions of an online tutoring experience.

Foundational Basis

Much learning today is supported in some way by information and communication technologies (ICT). Recent research reports that ICT supported learning is growing. At the same time, studies report that drop-out rates for such non-traditional learning vary from 10% – 75%.[10]
Chang grouped factors that may cause such high drop-out rates, calling the groups (1) barriers (including technology problems), (2) unmet student expectations, and (3) faculty time limitations. Factors contributing to unmet student expectations include timely response time, comfortable student-instructor and student-student relationships, and supportive instructor-student relationships. Faculty time limitations contributed to problems with timely response, supportiveness, and relationships.[4] These studies point to the fact that "quality e-learning needs efficient and quality student support".[10]

One way to support students in non-traditional ICT based learning is through tutoring. It has long been established that tutoring, which is one-on-one instruction between a teacher and a student, is very effective at producing learning.[2] Tutoring is characterized by (1) interactivity between tutor and learner with properties of collaboration and (2) individualized, adaptive, creative explanation.[3] It makes sense that students taking a course in a non-traditional format might also need a tutoring solution that allows them to remain off site, since the course format (at least partially) enables this benefit. An online tutor uses ICT to work with students on a one-on-one basis (generally) in order to answer student questions and guide students to successful completion of assignments and/or adequate test preparation. Tutoring for quantitative STEM courses often requires the tutor or student to write complex sequences of equation statements that comprise a problem solution process. The online tutor and student are generally separated in terms of location, with the temporal context being either synchronous or asynchronous. Benefits of online tutoring for ICT-based learning cited in the literature include alleviating student isolation, circumventing problems of faculty time limitations, and reducing attrition rates.[10]

Commercial online tutoring services have been available since approximately 2000. Many of these services provide private pay/single-user options as well as multi-user organizational subscriptions. For example, *ThinkingStorm.com* offers online math and science tutoring at levels up to SAT preparation; the program includes high school classes that prepare the student for Advanced Placement exams for college credit.[8] The *ThinkingStorm.com* website describes three subscription formats targeting individuals. Public libraries are major institutional subscribers to online tutoring services. The tutoring service is then offered free to library clients. These services are popular and are being used by families in support of K – 8 education.[9] Both public and private institutions of higher education look for ways to improve retention and streamline students' progress toward degree completion. Many offer tutoring services at no cost to enrolled students**;** thus**,** as non-traditional format course enrollments increase**,** these institutions seek ways to provide online tutoring options.

Institutional Infrastructure

Individual tutoring from the course instructor is a definite advantage, because students benefit from the instructor's course specific expertise. Although on-line tutoring can be offered by individual instructors, they are limited in how much they can provide. There are, after all, multiple demands on an instructors' time. The instructor must serve as subject matter expert, course manager, course developer, technology help desk for the course, etc.[4]. A system of online tutoring to support a variety of courses and instructors has advantages related to economies of scale and utilization. However, this system requires planning and thoughtful execution.

In the College of Technology at University of Houston, the availability of an Instructional Support Services (ISS) Lab, including trained tutors, provides a stronger basis for offering a broad online tutoring program than the tutoring program that is offered by an individual instructor. The ISS Lab is both an organizational unit and a designated computer-equipped lab space within the onsite college facility. Originally, the ISS Lab was designed to assist students with mathematics and computer courses in their major area of study, but it subsequently expanded to assist with other courses offered within the College. The designated space consists

of a room equipped with 25 computers and staffed by a lab manager, part-time staff, and graduate assistants. Successful as a meeting place for students and TAs, services offered have expanded from basic tutoring to assistance with using software, a site for proctored make-up exams, assistance with using the University of Houston standard learning management system (WebCT Vista and Blackboard), a collection point for hard-copy student assignments, a distribution point for hard-copy student assignments, a human information and support source for general course questions, and test practice for the math portion of the GRE. In addition, the ISS Lab provides support to faculty through WebCT assistance (upload assessments, implement grading forms, design, etc.), Wimba Live Classroom management assistance, programming a large test bank for mathematically based assessments, technology and/or software training sessions for faculty and GAs, and individual software help.

Within the last two years, the ISS Lab has added online synchronous tutoring using web conferencing tools. On-line tutoring was made available to students enrolled in applied statistics courses (undergraduate and graduate sections), advanced computer applications courses, a numerical methods course, and a merchandising mathematics course. During the 2008 – 2009 academic year, approximately 525 students were enrolled in these classes. Using Wimba Live Classroom and later Elluminate, students were able to discuss problems and share software with the tutors/instructors. Tutors were able to write equations and problem solutions on the whiteboard using a Cyber pad electronic tablet and pen. In general, the technology enhanced the display of progressive problem solutions interchanged with explanatory audio. This format mimics face-to-face on site tutoring. It was planned that the method be expanded to other courses, with these offerings serving as a model for these courses. The factors essential to this process are described in a subsequent section.

Action Research Approach

Action research (AR) emerged as a method of inquiry in the 1940s from the field of sociology, but it has expanded to the field of education as well. AR is a form of inquiry characterized by several properties. One property distinguishing AR is that it often has a practical purpose in addition to a theoretical purpose. AR generally attempts to solve a social or organizational problem, and to also study and evaluate the solution process and the solution. Avison, et. al. describe action researchers as being directly involved in planned organizational or social change.[1] Hansen, et al, provide examples of AR that match this description and place the organizational change in a higher education program assessment context.[6] Another characteristic is that the researchers participate in the process or problem being studied, as opposed to adopting an external observation-only role.[5] A third characteristic of AR is that it generally involves an iterative process of cycles that include steps of planning, implementing and observing, and reflecting and assessing.[1] The reflecting and assessing phase of a cycle generates the problem to be solved by the next cycle of AR or it results in termination of the AR process. For the AR process results presented here, there were several cycles of planning and implementation followed by reflection and revision. The process began with the identification of the problem.

Problem Statement

Students enrolled in online and hybrid format courses at University of Houston had access to on-site tutoring through the ISS. On-site tutoring served the population of students who needed tutoring and who maintained a regular presence on campus. But other students, particularly those enrolled in online courses, needed access to tutoring with fewer constraints of time and location. Furthermore, the tutoring needed to accommodate quantitative and computer-intensive content. The proposed solution to the problem was to implement an online tutoring option.

The first planning/action cycle involved assessing the institutional infrastructure already in place for its potential expansion into online tutoring and also reviewing the literature regarding online tutoring implementations. An internal grant supported efforts to provide an on-line tutoring program through the Instructional Support Services Lab. The program had to be easily accessible to students and capable of demonstrating the solution to quantitative problems in real time. It had to be capable of presenting both solution sequences involving equations and those that require software solutions. Following an analysis of the problem and resources, the process was first implemented for courses that were offered in the 2008 summer session. In this and subsequent semesters, the process was continually analyzed and based on observation and analysis, the system was modified with continued offerings.

Program Development Considerations

Observation, modification and analysis regarding the program during implementation revealed the following significant factors affecting the program outcomes.

1. Content
2. Technical Issues/Software and Hardware
3. Training
4. Scheduling and Participation
5. Privacy

Content Although the mission of the ISS Lab has expanded over the years, historically, it was directed at tutoring of quantitative courses. Even with the expanded mission, most tutoring in the ISS Lab remains directed at this type of course. Thus, on-line tutoring was developed for courses in statistics, computer applications and numerical methods. Considerations related to content selection included the following.

- Course enrollment influences tutoring needs. Online tutoring should be directed at courses with strong enrollments so that utilization data might be used as an indicator of success.
- In order to effectively present content that included equations and symbols plus specialized application software to the students in real time, equipment and software beyond standard office productivity tools is needed for online tutoring Details of these needs are discussed in more depth as part of the Software/Technical Issues section that follows..
- Courses selected for online tutoring support should also have a base of faculty interest. Students must be made aware of the availability of online tutoring; one resource for this information exchange is the faculty member who is teaching the supported course. In the

ISS implementation, faculty members occasionally serve as a moderator and/or participant in the online tutoring sessions. This participation is a useful method to inform the faculty member of the quality of tutoring support available, to identify improvement opportunities, and to make the available service more visible to student consumers.

- In general, best results are achieved when advanced planning is conducted prior to adding support for a course. The planning includes tutor preparation and attention to technical issues. In addition, faculty concerns and special needs can be considered. If a student seeks tutoring and finds it lacking due to technical difficulties or unprepared tutors, the student is not likely to seek help again. The student may also broadcast negative information about the tutoring service to peers or faculty members. Once the reputation of an innovation is damaged in this way, it may be difficult to regroup and recover.

Software/Technical Issues Review of resources and an initial test of these resources resulted in implementing the online tutoring program using a web conferencing tool. Ultimately two web conferencing tools were used, Wimba and Elluminate. Both tools offer features that have become somewhat standard to web conferencing software including a virtual classroom/conference room that delivers full-duplex voice over the Internet, optional real-time video with lip-synced audio, a shared interactive whiteboard, instant messaging (chat) inside the classroom, desktop application sharing, breakout rooms for student small groups, PowerPoint presentation import capability, archiving with indexed recording and playback, support for use of rich media content, instructor-controlled classroom usability options, participant status indicators, active URLs in chat and whiteboard, instant participant polling, and emotion and activity indicators. Successful implementations require that no serious technical problems be present. Factors relating to technical success that were found to be important included:

- Minimal voice delay
- Capacity for application sharing through shared windows and with multiple shared windows
- Minimal time to upload files
- Ease of use by students, tutors and faculty
- Capability to write mathematical statements

In considering hardware, it was determined that hardware must support the presentation of written mathematical statements. Each web conferencing tool offers a whiteboard, but writing on the whiteboard by using a mouse as a pen is not a satisfactory solution. Electronic tablets (such as Adesso CyberTablet products) provide a pressure-sensitive tablet and cordless pen, together with software that lets the user draw and write naturally to present information via the whiteboard. Newer products include standalone digital devices with internal storage that digitally capture and store everything written or drawn with ordinary ink on plain paper (e.g., Adesso's CyberPad). The devices connect to desktop computers via USB ports for notes and image transfer. Connected to a PC, the devices also serve as electronic tablets to interact with whiteboards of web conferencing tools. The tablets offer software for handwriting to ASCII text conversion as well. Another option is a digital document camera (such as Elmo products); these devices convert high-resolution visual capture of writing, drawing, or demonstration to digital format.

For the online tutoring implementation discussed here, CyberPad has proved to be a satisfactory solution. A limiting factor is that the hardware is generally only available to the tutor; students do not necessarily have the equipment and software for digital ink generation. The result may be one-directional communication that is not as effective as two-way writing, but tutors can be trained to use creative workaround solutions such as eliciting student verbal direction for what should be written.

Training Implementation of a training program is necessary for all users including tutors, ISS managing staff (or equivalent), student users, and faculty. ISS professional staff needed training to provide effective program development and on-going training opportunities for other constituencies. Tutors must be proficient in both the use of software and hardware for tutoring and in the content area for the supported courses. Students must know how to make inquiries and how to access the web conferencing tool from off-site. The help provided students must be well-designed so that it is easily accessible and self-teaching. Faculty training should be designed to enhance enthusiasm for the service. The trainer must understand the software and hardware so that no technical difficulties emerge during the training sessions. If faculty members see a service that is well-planned and executed, they will encourage and support student use of the resource.

Existing ISS infrastructure was critical for implementing training for online tutoring. ISS professional staff secured and trained tutors in the use of the software and hardware. ISS staff also determined if tutors needed support in terms of subject matter from supported content areas, and if so, made arrangements for the tutors to audit relevant courses. Additionally, ISS staff established training seminars for faculty using a hands-on workshop format. These seminars were offered both on-site and online. ISS staff created training materials for students, including a quick-reference guide for student use. The quick-reference guide was made available online, and helped students navigate the web conferencing tool in order to access the online tutor.

Scheduling and Participation The most perplexing problem was scheduling tutoring sessions. Based on a class survey (n = 18), the initial offering was implemented one night per week at a specific/scheduled time. After implementation, results of student perceptions for this offering were evaluated. These results can be viewed in Table 1.

TABLE 1
Student Perception of On-Line Tutoring

Category		Item	Response		
			Yes	OK	No
Tutors	1	Tutoring was helpful	54%	24%	22%
	2	Clear and organized tutor explanations	57%	24%	19%
	3	Tutor was prepared	80%	20%	0%
Structure	4	Sufficient length to help with class	86%		14%
	5	Convenient Time	70%		30%
	6	Convenient Day	66%		34%
Technical Aspects	9	Technical difficulties during the session	20%		80%
	10	Technical difficulties resolved	40%		60%
General	7	Will attend other online tutoring	80%		20%
	8	Higher grade on an assignment because of tutoring	38%	41%	21%

Based on the survey results, staff members concluded that students saw tutoring as generally helpful (indicated by 1, 7 and 8). However, there were student concerns regarding the day and time structure and perhaps more significantly, there were some technical difficulties.

Based on the survey results, scheduling was changed, and online tutoring became available during all of the on-site ISS lab's operating hours. Graduate assistants in the ISS lab were assigned to the task of monitoring the online "arrival" of a student question through the web conferencing classroom. The graduate assistants were prepared to discuss questions with students online during all of the operating hours (40 hours) of the lab. However, in actual practice, it was determined that the graduate assistants were not being utilized efficiently while waiting for online tutoring requests. In the subsequent semester, online tutoring sessions were offered using an appointment system. Students sent email requests for tutoring appointments to ISS lab personnel.

Over the course of the implementation, an average of 22% of the on-line students participated in online tutoring while an average of 19% participated in on site tutoring. It is difficult to assess whether these percentages represent an adequate participation rate for tutoring. Tutoring is being utilized sufficiently when all students' learning needs are being satisfied.

Privacy Web conferencing tools have an optional capability to record and archive sessions. Instructors using the tool for course presentations often archive sessions so that they can be made available to those students who are unable to attend in a synchronous mode. Tutoring sessions involve one-on-one interactions between a tutor and an individual (identifiable). It might be tempting to archive these sessions and make them available to other students with similar questions. To do so without the explicit permission of the student seeking help would be a violation of that student's right to privacy. Thus, if electing to archive sessions, participants must be informed in advance and one must consider the implementation of a privacy policy.

Summary

Review of the online tutoring implementation determined the following issues critical to overall success and a viable student participation rate.

- Ensure full coordination with the faculty members who are responsible for the courses, as they determine course content and pace. In our analysis, it was effective for all faculty members to place an icon on their course homepages that linked students to the ISS lab's website where students could review the services offered including online tutoring. Some faculty members encouraged students to use the online tutoring service with extra credit incentives.
- Communicate with faculty and students regarding the service; include announcements regarding web conferencing training and tutoring availability.
- Ensure technical viability of all software and hardware options implemented.
- Ensure capable, trained tutors. Tutors must be proficient in both the use of the web conferencing tool as well as the course content.
- Review timing so that online tutoring is convenient for students. Student commitment to a specific time increases their commitment to attend.
- Develop an online sign in process to better monitor program utilization.
- Develop a privacy policy so users are aware of session recording options.

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