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## Evolution of a Computer-Based Testing Laboratory

by Patrick Moskal, Richard Caldwell, and Taylor Ellis

The College of Business Administration ([CBA](#)) at the University of Central Florida ([UCF](#)) has an enrollment of over 9,000 students, which is the second largest in the nation among accredited business schools. As the school has grown, the number of technology-based and large-enrollment classes has increased and, with them, the challenges of providing appropriate, workable assessment opportunities for students.

Large-enrollment classes present particular challenges; the very large number of students in these classes—250 or more—makes administering and grading paper-based exams difficult and time-consuming. Faculty need an efficient way to administer exams that maintains exam security without increasing their workload. Students want a secure, quiet testing environment and quick feedback on exam performance. Around the year 2000, the CBA began to research computer-based testing as an alternative to meet the assessment needs of the college's growing number of technology-based and large-enrollment courses.

We believed that a computer-based testing laboratory was our best option for responding to these needs. To learn how to develop a lab successfully, we investigated several existing testing facilities at universities around the country, including the [Math Emporium](#) at [Virginia Tech](#), the [testing center](#) at Brigham Young University ([BYU](#)), the [testing laboratory](#) and software at [Ball State University](#), assessment software used at James Madison University ([JMU](#)), and essay grading software used in Florida Gulf Coast University's ([FGCU](#)) [testing center](#). The Math Emporium most closely approached our vision for a lab, and we ended up using the Ball State testing software.

The initial plan was to include as many networked computers as possible in a large classroom space that would be available for teaching software applications to students as well as for testing. We intended to use a software package that would support immediate grading, multiple exam question formats, test item analysis, exportable data, and security features. This paper describes the development and evolution of the lab, details the lessons learned from our experiences in developing the lab and accommodating continued growth, and discusses plans for further development.

### Early Developments

The lab opened in Fall 2003 with 141 networked PCs obtained at no cost from campus surplus. Internet access and limited storage was provided for each machine, and four computers were configured to meet accessibility standards required by federal law (U.S. Department of Justice [2005](#)). In lieu of a course management system, the college purchased a more narrowly focused assessment package that allowed exams to be administered simultaneously on all lab computers ([Exhibit 1](#)).

In 2005, in response to growing demand, operating hours were increased from 47.5 hours per week to 70.5 hours per week. In the same period, 23 additional computers were added, bringing the total to 164, and security was increased with the addition of 15-inch flatscreen LCD monitors installed at an angle and fitted with filter screens to limit students' viewing to their own screens ([Figure 1](#)). This configuration decreased the potential for cheating. At the same time, in response to challenges with the assessment software linked to the substantial growth in usage, we switched to WebCT (which has since merged with [Blackboard](#)), the platform used by UCF's distance learning programs. Because UCF provides operation, maintenance, and backup of the university's WebCT system for all users, this change also relieved CBA personnel of system maintenance responsibilities, which proved to be an additional benefit.

Initially, faculty members reserved the lab during scheduled class periods to administer exams collectively; larger sections had scheduling priority. Large-enrollment courses required more than one class period; a class of 500 students, for instance, required four testing periods. The first session was scheduled during the normal class meeting time and the others consecutively after. Some faculty members added a section in the evening for students with scheduling issues. To manage exam administration across multiple sessions, we developed online scheduling software that allowed students to make a reservation in one of the available testing sessions. The software tracked available seating for all sessions and provided a student roster for each session. Students could change their reservations up until the beginning of the first exam session as long as seating was available.

Students gained access to the lab by presenting a UCF photo identification card or driver's license, which was cross-referenced with the class roster. The instructor also provided an exam password that students were required to enter at the lab computer in order to access the exam. The assessment software set exam start and end times, and the password was reset once the exam began, thereby limiting exam access.

Faculty members and their graduate assistants monitored exam administration, providing exam-related assistance and security. Lab staff members were also present to respond to equipment or network problems, but they did not answer course-related or exam-specific questions. Involved faculty must be prepared for extreme situations, such as power or server failures or forced evacuations, and include in their syllabi provisions for alternative testing procedures.

## **Adapting to Growth**

By Fall 2006, usage had tripled, with 23,084 exams being administered as compared to 7,504 in the first semester of operation ([Figure 2](#)). Usage continues to grow; the lab administered over 120,000 exams in 2008, four times the number administered in 2005. This rapid growth is reflective of the increasing use of the lab by our faculty. Part of the recent growth was also due to CBA course modifications in 2007 that allowed many lower-level courses to be offered to remote students via video streaming. Courses offered in this way typically have enrollments of over 1,000 students, and testing in these courses is conducted exclusively in our testing lab and in branch campus computer labs.

Block exam scheduling became too difficult in the context of the increased demand, so we moved to open testing in 2007. Faculty members now allow students to take exams within a specified time period, usually three to five days. Students take exams on a first-come, first-served basis during the lab's operating hours, which have been extended to 93.5 hours per week and now include Saturdays. Because open testing allows us to maximize computer use, over 18,000 exams can be administered each week, a number derived from a 48-minute average exam time based on actual observations of more than 90,000 exams. In-house surveys indicate that students like this approach.

To facilitate student check-in and check-out, an electronic card reader that reads only UCF student ID cards has been installed. The reader facilitates the automatic display of the student's photograph on the check-in PC, which also calculates how many seats are available at a given time and lists exams ending each day and during the week. Seat availability and exam information are displayed on a monitor mounted outside the lab and made available online so that students can check which exams are currently open and if seating is available before they come to the lab ([Figure 3](#)).

As lab usage expanded, the CBA hired a full-time WebCT coordinator to provide support and training for faculty members using WebCT and to support the testing lab. Discussions with faculty members indicate that the availability of an in-house WebCT coordinator who can be available immediately when problems arise is preferable to relying on the university's IT personnel. Moreover, lab administrators now hire, train, and manage student proctors, alleviating this burden for faculty members.

## Ensuring Security

Data security is imperative for a facility that handles confidential student records. Numerous accounts of hackers accessing universities' records indicate a real risk for data compromise with the potential for severe consequences. Since 2005, [California State University, Chico](#); [California State University, Fresno](#); the University of California, Los Angeles ([UCLA](#)); the University of Texas at Austin ([UT](#)); and the University of Florida ([UF](#)) have reported major breaches of their computer systems (Hines [2005](#); Fox News [2006](#); McMillan [2007](#); Brocchetto [2009](#); UCLA [2009](#)). We try to counter this threat by providing a highly secure testing and administration environment protected by data encryption and password protection. Thus far, we have been successful in preventing unauthorized access to our system.

For added examination security, we installed cameras in the lab area in 2007. Intended both to serve as an after-hours theft deterrent and to monitor student activity during exams, the cameras provide views of the lab's entrance area as well as of all computers. Tilt, pan, and zoom functions allow the cameras to provide clear views of PC screen content and materials placed on the tables; lab staff members can manually adjust cameras to record suspicious or inappropriate activity. After hours, motion sensors activate the cameras.

[NetSupport](#) software, also installed in 2007, provides additional exam security as well as other educational features. Most notably, it allows a faculty member or proctor to monitor all 164 computer screens simultaneously; each screen appears as a real-time, thumbnail image on the instructor station's 26-inch monitor. The software also blocks student access to unauthorized Web sites, e-mail, and software applications. In addition, it can record everything that occurs on a particular computer. In one instance, a staff member observed a student logging into the account of another student who was taking the same exam. He copied her answers, logged back into his own exam, and then used her answers to respond. The staff member activated the software's recording function from the instructor station; the software recorded the sequence, and the course instructor was notified.

The shift to WebCT also increased security by allowing us to use a restricted IP address, preventing access by anyone outside of the lab. We have also added a WebCT add-on—Respondus Lockdown Browser ([LDB](#))—that blocks students from opening other applications or browser windows during exams. Before the implementation of LDB and NetSupport, students were adept at hiding access to other Web sites or e-mailing other students. Cheating is still a concern, as it would be in any classroom, but we feel that we have been able to keep ahead.

Data back-up is as important as data security. Loss of exam records can result in mid-semester course modifications and significant student and faculty dissatisfaction. UCF's Course Development and Web Services Office creates back-ups of all WebCT course information each day, including exams administered in our lab, preventing accidental loss of these records.

## Benefits

We have found a number of benefits to the use of a dedicated testing laboratory with open testing. Both students and faculty members have expressed satisfaction with the arrangement, and we have observed other benefits as well, particularly in the lab's ability to facilitate program assessment activities.

## Student Satisfaction

During the first few weeks in April 2007, students enrolled in eight courses that used the lab for exams were asked by their instructors to participate in an online survey about various aspects of the lab, including the open testing format, the operating hours, and their general satisfaction with the operation and availability of

the lab. The survey was completed outside of exam sessions; students could complete a survey from any computer with an Internet connection. All participants were students who had taken one or more exams in the lab. A variety of courses were selected, including three video-streamed courses with 600 to 1,000 students enrolled in each. The total enrollment of these courses was approximately 3,500 students; thus, the survey response rate was about 33%.

An overwhelming majority of students who responded (1,022 out of 1,185; 86.2%) indicated that they were satisfied or very satisfied with the lab's operation; only 85 students (7.2%) indicated that they were dissatisfied or very dissatisfied.

Anecdotally, we have observed that students often respond positively to receiving exam results immediately upon exam completion. Students have also mentioned in conversations with us that they enjoy the freedom to take exams at their convenience. In a study conducted in the lab (Euzent et al. 2007), students expressed a preference for computer-based exams, indicating that answers were easier to enter and cheating was less likely on computer-based exams and that they found computer-based exams less stressful than paper-based exams. The study also found that students' performance on exams was about the same whether the exam was given on paper or via a computer ([Exhibit 2](#)).

## **Faculty Satisfaction**

Faculty members have expressed appreciation for the flexibility of WebCT's exam creation utilities; in addition to the multiple-choice exams preferred by many instructors, WebCT allows multiple-response, true-false, short-answer, and matching questions, all of which can be automatically graded. Some faculty members use a combination of question types, and one of our graduate professors uses the software's capability to include essay questions. Students type their written responses in a secure environment; the professor prints them and grades them at his convenience. In addition, some textbook publishers provide WebCT-compatible test banks from which faculty members may pull questions. WebCT also provides increased exam security because faculty can randomly pull questions from a question bank. Moreover, WebCT allows exam questions and the corresponding answer choices to be randomly presented so that each student potentially receives a different exam. One CBA department offering multiple sections of a large course has developed a question pool from which WebCT selects items at random, essentially generating an individual exam for each student. This combined with the fact that students cannot take written materials from the lab makes it very difficult for early test takers to pass information to other students.

Because WebCT automatically computes various exam statistics and provides item analysis, faculty members using automatically graded question types no longer grade exams. In fact, with proper exam preparation and open testing, faculty members are now rarely present when exams are administered. While instructors were initially reluctant to give up control of their exams, many have indicated in conversations with us that they now consider this a benefit. The ability to administer exams outside of class time also means that instructors have more meaningful classroom contact time with their students.

## **Other Benefits**

The testing lab has also helped to facilitate program assessment. Some CBA courses use the testing lab to collect student performance data for program assessment purposes ([Exhibit 3](#)). One of our marketing courses, for example, uses 20 assessment questions embedded within 3 exams to assess a learning outcome on ethical reasoning. This subset of questions is graded as part of the regular exam, but students' responses to those questions are also exported to a spreadsheet for analysis as part of the CBA's program assessment process. We anticipate a greater use of the lab for program assessment as more faculty members use it. One future goal is to develop software that will make extracting program assessment data more automatic.



Finally, over time, computer-based exams can offer significant cost savings over paper-based exams. With over 338,000 exams administered since the lab opened, we estimate a savings of between \$135,000 and \$163,000 in the cost of paper and copying alone, based on an average of 10 to 12 pages per 50-item exam at the university's \$.04 per page copying price. Moreover, faculty members save substantial time because they no longer grade and return paper-based exams although they must still develop exams and ensure they work properly in WebCT. Although this preparation is more involved than creating paper-based exams, faculty members using the lab have not returned to using paper-based exams.

## Issues

Negative comments from the April 2007 student survey have indicated that noise during open testing is disturbing for some students. We have worked to reduce noise levels by providing cloth-covered cubicle walls between the check-in/check-out area and the exam area and by adding additional walls outside the lab to direct students away from the entrance. Moreover, we replaced the lab's storage cubbies with a room equipped with pay lockers, reducing crowding and ambient noise near the lab entrance.

A larger issue has been long wait times to take exams. With open testing, our analysis of usage data has shown that over 80% of students wait until the last two days that an exam is available and over 52% wait until the last day ([Figure 4](#)). In the period just after the lab shifted to open testing, this phenomenon led to long wait times for students during midterms and finals when a much higher number of exams are administered in a short period of time. Long waits contribute to student dissatisfaction, so reducing wait time is essential.

Extended lab operating hours have helped. During Fall 2008's finals week when over 13,250 exams were administered, the longest wait period was 45-60 minutes. Eventually, students will acclimate to the open-testing format although some waiting during peak times may be inevitable. For Spring 2009, we are planning to experiment with a speed-pass system similar to that used in popular theme park attractions; during peak exam periods, students will have the option to register online for an exam timeslot with a 10-minute window, which will allow them to move to the head of the line if they arrive during their assigned timeslot. We hope that this procedure will free students from waiting in line to get into the lab. They will however have to keep track of their entrance times.

The increased traffic has also created a need for more vigilance regarding the materials that students bring into or take from the lab. Now, lab staff distribute the assistive materials allowed by the course instructor and stamp them according to date and course. No other materials are allowed into the lab. Students must return provided materials before leaving the lab; the check-out system notifies the staff what materials need to be returned. These measures have reduced the likelihood that students will bring in unauthorized materials or leave with exam information.

## Conclusion

Through sound initial planning, trial and error, and the implementation of appropriate support systems, we have created a state-of-the-art testing facility that has become an essential part of CBA programs. We continue to strive for increased efficiency and for student and faculty satisfaction. To achieve these goals, several improvement measures are planned for the future. We want to convert all paper-based assistive materials to an electronic format that can be embedded within exams or located on the computer desktops. This will make check-in and check-out more efficient and increase exam security.

In another attempt to improve efficiency, we envision adding turnstiles equipped with card readers at the lab entrance so that students can check themselves into and out of the lab. Upon entering, each student would be assigned to a particular computer that would also be fitted with a card reader; students would scan their cards again at the assigned computer to link to their initial check-in and gain access to the exam. They will

automatically receive the assigned exam and assistive materials. These modifications will remove the need for lab staff in the check-in/out process and will hopefully provide a more pleasant experience for our students.

The testing lab has met CBA's need for the assessment of large numbers of students in a modern, secure environment. The lab has evolved over the past five years to meet the changing needs of our students, to maintain security, and to keep up with changes in technology. As more universities consider moving in this direction, our lab can serve as a model that can provide insights into the available technological options and potential challenges of implementing computer-based assessment on a large scale.

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