

USING MULTIPLE ONLINE SECURITY MEASURES TO DELIVER SECURE EXAMS TO TEST TAKERS

A White Paper



Webassessor

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Professional Opinions Disclaimer

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USING MULTIPLE ONLINE SECURITY MEASURES TO DELIVER SECURE COURSE EXAMS TO DISTANCE EDUCATION STUDENTS

Abstract

This report describes the successful first-ever pilot of Online Proctored Testing. The World Campus of Pennsylvania State University (PSU) and KRYTERION, Inc., teamed up to administer course exams securely and online to distance education students located in several states across the country and to a student outside the United States. Over 89 exams were administered to students in Horticulture and Physics courses, mostly in their homes, using a variety of new security technologies, including online proctoring, Real-Time Data Forensics™, biometric authentication, and others. The combination of these technologies assured the identity of each student and the security validation of the test scores. The study clearly demonstrated the feasibility of secure testing over the Internet wherever students are located.

Introduction

Distance education institutions have struggled in recent years to find a convenient and secure way to administer online, proctored exams to their students. While the instruction is generally delivered conveniently to a student's home or work through the Internet, it hasn't been possible to provide the tests using the same technology, primarily because the security of the exam could not be assured and because it has been difficult to authenticate the identity of the student taking the test. As a result, universities and colleges offering online distance education courses, and even some high schools, have resorted to a number of difficult options. Some organizations ask the students to "find your own proctor". Others provide paper-and-pencil tests sent by mail. Both of these require the difficult steps of finding someone to assist the student in taking the test, getting contracts signed, dealing with schedules and sometimes payments, and hoping that security measures are taken. These options take a great deal of both the organization's staff and student's time. The process then has to be repeated for the next exam. Some distance education institutions provide unproctored or unmonitored Internet testing. They have the student simply sign an "honor code" agreement as the sole security procedure, hoping that the student won't cheat, won't share the test with others, or won't have someone else take the test for him or her.

The security issues have been severe enough that some programs have done away with testing altogether. Of these, many use other forms of assessment including student portfolios, papers, projects and other types of student work. Of course with these methods, the same security problems remain.

It is logical to assume that distance education providers would prefer a testing solution that is Internet-based, at least as secure or more secure than testing that occurs normally for on-campus programs, and which allows for convenience that is so highly prized in this market.

KRYTERION, Inc., based in Phoenix, Arizona, has developed a product called Webassessor™ which provides Online Proctored Testing wherever and whenever needed. Security technologies especially developed for Webassessor™ include:

- ∴ Keystroke Analytics™ and digital photographs that biometrically identify and authenticate a student
- ∴ Online proctoring using webcams that are enabled with audio to monitor test takers and to deal professionally and objectively with students who have technical difficulties with the exam or who attempt to cheat
- ∴ Real-Time Data Forensics™ is a sophisticated ongoing statistical analysis of answer and answer latencies that is used to detect unusual patterns of how students are responding during a test
- ∴ Secure browser control to make sure students cannot access Internet and other resources on their hard drive during the exam
- ∴ Keystroke monitoring to detect and prevent the use of unauthorized keystrokes (e.g., Alt-Tab, Prnt-Scrn, and others)
- ∴ Secure test and Item designs which minimize exposure of questions and question content
- ∴ Ability for faculty to review recorded test sessions when they feel it is necessary

With these multiple and effective security measures in place, tests given online as part of a distance education program are as secure, if not more so, than tests given in classrooms, campus testing centers or other professional testing locations.

Recent federal government legislation, the “Higher Education Opportunity Act of 2008¹,” provides for accrediting agencies or associations to require that distance education programs validate the identity of the distance education student and provide assurance that the course work completed, including tests, was completed by the actual enrolled student². Using the Webassessor™ security methods, data can be routinely gathered to establish compliance with the Act.

A Case Study: Piloting Online Proctored Testing at PSU World Campus

A pilot of Online Proctored Testing using Webassessor™ was carried out for two PSU World Campus courses, Horticulture and Physics, during the summer of 2008.

1 Bill H.R. 4137 was signed into law August 14, 2008.

2 H.R. 4137, Section 496, Part H – Program Integrity, 4(B)(ii).” the agency or association requires an institution that offers distance education or correspondence education to have processes through which the institution establishes that the student who registers in a distance education or correspondence education course or program is the same student who participates in and completes the program and receives the academic credit.”

Test questions for the Physics and Horticulture course tests were entered into Webassessor™ by World Campus Learning Design staff. The published exams were then made available to the students through Webassessor™ over the Internet. Each course included the administration of three exams over the semester with testing windows established by the instructors.

Participating students were asked to purchase a specified webcam and were also provided with the names of vendors that had the cameras in stock. The price of the camera was viewed as minimal for participation in the course as the camera could be used for other courses and other online course features (i.e., Video Chat, Collaborative Groupwork, etc.). PSU's World Campus already required broadband Internet availability as a pre-requisite to taking courses online, so the webcam requirement did not result in any additional expense beyond the camera's purchase price.

Preparing to Take Tests. Students needed to complete a few steps a single time as preparation to take the course exams securely through Webassessor™. Once these were done, the first test—and all subsequent tests, even for other courses—could be easily taken.

Step 1. After purchasing the webcam, students had to make sure it was installed properly. They did this by following the instructions and using the installation software.

Step 2. Students then enrolled or registered into the testing system. Using Webassessor™, students accessed their home page. From there, following on-screen prompts, they were able to take an initial enrollment digital photograph using the webcam. This photograph served as the verification photograph throughout their time with PSU's World Campus.

Step 3. Continuing the registration process, students biometrically enrolled using the Keystroke Analytics™ methodology in Webassessor™. This simple process took approximately three minutes. The student was given a system-generated 15-character phrase and required to type it an average of nine to 15 times. Keystroke Analytics™ then produced a “digital signature” for the student that cannot be replicated by anyone else. When a person reproduces his or her “digital signature” correctly, tests are able to be launched.

Step 4. Students were also instructed to download Webassessor Sentinel Security Shield™ (Sentinel), a very small program responsible for locking down the browser at exam time. During the pilot, the browser was restricted to Windows Internet Explorer and Mozilla Firefox, both for the Windows operating³ system. Instructions on how to download this small program were available on PSU's Angel Learning Management System (LMS) as well as on the Webassessor™ student home page. For Sentinel™ to work, Adobe Flash Player needed to exist on the student's computer. If it wasn't already on the computer, it was downloaded and installed.

Step 5. While not required, students were also encouraged to view a tutorial to familiarize themselves with the technology and the various steps that would be required at test launch time.

3 The Safari browser for the Macintosh operating system is now supported.

Scheduling Exams. Upon successful completion of these preparatory steps, the students could then schedule their first exam. For this process they had to navigate to their home page and enter a pre-determined exam code that was given to them within the Angel LMS. As long as the exam-scheduling window was open, the students could self-schedule for an exam by choosing a day and time convenient for them. All exams had to be scheduled at least 48 hours prior to the close of the testing window. Changes to the schedule for exams were handled by the World Campus Help Desk and the individual instructors.

Launching Exams. At the scheduled test time, launching the exam required a few simple authentication steps. First, the students took another digital photo of themselves with the webcam, called the “test launch” photograph. This is used by online proctors (described below) to launch the test by comparing it to the original enrollment photo already provided. Second, the students were prompted to type their “digital signature”—the unique 15-character authentication phrase—and were given three opportunities to type it as they did when they enrolled.

If the Keystroke Analytics step could not be completed, the student called a KRYTERION online proctor where an immediate visual match between the launch photograph and the original enrollment photograph could be determined. The proctor was then able to override the Keystroke Analytics™ requirement and authorize the test launch.

As part of the launch process the students were asked online to agree to having the test session audio and video recorded. As part of that online agreement the students were also asked to read and agree to the PSU Academic Integrity Statement. Having successfully passed the authentication and online agreement steps, the test launch button was activated and they could begin the exam.

Proper placement of the webcam was critical in allowing the proctor to view the hands, keyboard and face of the student during the test. Documentation was supplied to aid students with positioning their webcam⁴.

Taking the Test. During testing, students were monitored by two levels of human proctoring and several types of virtual or computer proctoring. Tier 1 human online proctors watched video/audio thumbnails of all students testing on a particular day and time (scheduled exams were spread across exam weeks for each course and were specified by PSU and the course instructors). These Tier 1 proctors monitored the thumbnails for overt security and other issues and sent alerts when problems were detected. Tier 2 human online proctors had access to more detailed views of the video/ audio stream as well as the photographs taken during enrollment and prior to the launch of the exam. These Tier 2 proctors were responsible for dealing with any security or technical issues that came up when the test was launched or while it was being taken. They handled any alerts from Tier 1 proctors and the automated virtual proctoring detection processes running.

4 While not available at the time of this pilot, Webassessor™ now supplies an “on-screen” live camera view to the students letting them see themselves as the proctor sees them. This eliminates any “guesswork” as to the proper camera placement and reduces the need for technical support.

One method of virtual or automated proctoring detection consisted of Real-Time Data Forensics™ which monitored the students' responses during the test looking for strange patterns such as too-fast responding. Inappropriate keystrokes were also monitored. For example, if a student attempted to use the PrntScrn (Print Screen) key during the test in order to record and save a copy of a test question, this action was noted and the online proctor was alerted⁵.

All aberrations and security risks during the test were handled by the online proctors who provided online warnings to the test taker when appropriate, and pausing or suspending the test when necessary. All of these alerts or “red flags” were noted in session logs and the World Campus staff was notified in case further action was required.

Results

Completion Rate. A total of 29 students completed 89 exams providing important scores for course completion. All exams were proctored under secure conditions with authentication and complete security monitoring by the system and staff as described. The Internet connections were consistent and the webcams functioned as designed. Six other students began the course(s) and may have even scheduled an exam, but did not take any exams.

Global reach. Of the tests administered, most were in Pennsylvania; however, there were a number of students participating from other states and even one student from outside of the United States. There were no obvious restrictions to where Online Proctored Testing could take place, providing PSU with the opportunity to confidently provide its services on a global scale.

Security. The deterrence value of Online Proctored Testing was clear. With close human and automated observation, only two security problems, one each for two students, were detected. This represents 2.2% of all tests given—a very low rate of security problems compared to published research on the general rates of cheating in college courses. The system's close monitoring made it very difficult for cheating to occur and go undetected. Here is a brief description of the two security incidents:

- ∴ One student was discovered by online proctors talking with accomplices in the testing area, describing a test question and requesting the correct answer. At least two accomplices were outside of the view of the camera. The student was warned by the proctor, acknowledged the warning, and completed the exam without further incident⁶.
- ∴ A second student was seen using headphones, which are not allowed during testing. The student was warned by the online proctor, the headphones were removed, and the exam was completed.

5 While students could attempt certain unauthorized keystrokes, such as Print Screen, Sentinel™ did not allow the actual command to occur.

6 The student actually stated that he had “forgotten that audio was also picked up”.

Technical process issues. While there were only two actual security incidents, the introduction of a new way to test securely online did reveal some procedural and technical steps needing improvement⁷. There were a total of 65 technical or procedural issues logged and dealt with by KRYTERION support staff and online proctors. It is important to note that 45 of the 65 technical issues were not related directly to taking exams but occurred during the set up process or during biometric enrollment and test scheduling. Thirty-seven of the 89 tests (mostly exams 2 and 3) occurred without any problems at all. Four students completed the setup, registration and scheduling, and all three exams with no technical assistance at all.

The most prevalent technical issues experienced by students were:

- ∴ **Failing to download Sentinel™ (and/or Adobe Flash Player as a pre-requisite).** The test will not launch without Sentinel™ (14 incidents).
- ∴ **Improper installation or placement of the webcam.** Without an acceptable video signal (20 incidents) or the proper view of the test taker's hands, keyboard, torso and head (15 incidents), the online proctor would not authorize the launch of the exam⁸.
- ∴ **Improper scheduling of exams.** While more of a problem with following instructions, five students failed to schedule within the time limit and six students scheduled the exam but didn't take the test. Two students scheduled the exam, but needed to reschedule for personal reasons. These types of scheduling issues are common for any group of students and the support staff was able to assist when needed.

The remaining technical or process issues were mixed:

- ∴ Internet connection failure (two incidents).
- ∴ The need to reset the Keystroke Analytics™ enrollment process (two incidents).
- ∴ Various minor software issues:
 - A student was able to launch a previously completed exam (one incident.)
 - The Backspace key would not work (one incident).
 - An enrollment photo was not available for the online proctor (two incidents).
 - The online proctor's Resume command (used to resume a test after pausing it) didn't function (three incidents).
 - Unexplained System Errors occurred (four incidents).

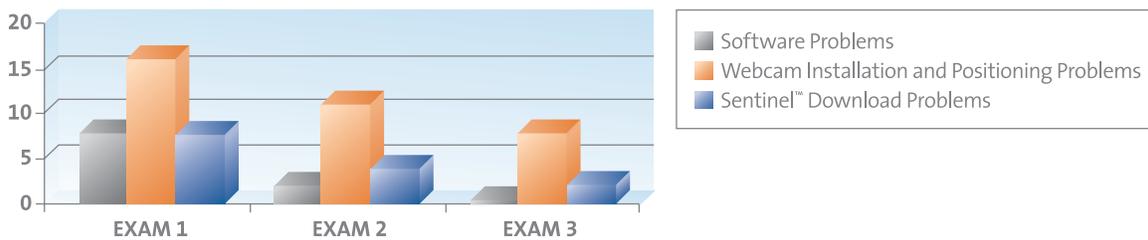
As expected, during the early weeks of the pilot when setting up, registering and taking the first exam, most of the students (82.7%, or 24 of 29) required some type of technical assistance, each

⁷ Some changes to student instructions and to Webassessor™ functionality were made during the period of the pilot and immediately reduced the number of support calls. Plus, changes made after the pilot finished made the process even easier for students.

⁸ As noted earlier, Webassessor™ now provides an 'on-screen' live camera view during the test launch steps.

problem needing 10 to 30 minutes for a support technician to resolve. All technical problems were easily resolved and all students were able to take the required tests without much delay. Of more interest, over the course of the pilot and because setup issues had all been dealt with early on, students became more familiar with the launch procedures and took subsequent tests; their support needs reduced to a much lower rate as well (see Figure 1).

Figure 1. Technical problems during the pilot, accounting for most of the support calls by students, reduced drastically over the time frame of the pilot and as students gained experience.



Survey Results

Student Survey. Students in both the Horticultural and Physics courses were asked to complete a short survey on their online testing experience. This survey was administered between the second and third exam in each course.

The results of the survey were mixed in regards to satisfaction with the online proctored testing experience. This was expected as students were being exposed to a new methodology and many were used to the previous paper-based system of exams. Approximately 50% of the students were excited with the online-proctored exams and commented on the convenience, while the other half were less enthusiastic. These latter students commented on problems with the camera installation, problems launching the exams (often due to the Sentinel™ not being installed), and issues with scheduling exams (sometimes due to the correct test code not being entered in a student’s profile). Also, a few commented they were uncomfortable with the idea of being observed online.

The survey results indicated that many students did not see as high a value as was anticipated for the immediate receipt of exam scores. This is a somewhat unexpected finding as it was assumed that this would be a big benefit for students, as they did not have to wait the usual three to four weeks to receive their exam results, as was the case with the paper-based tests.

World Campus Staff Responses. A post-pilot review was held with the PSU World Campus staff to get their opinions on the pilot. It was found that:

- ∴ The technology worked to provide convenient exams and improve security.
- ∴ KRYTERION’s support staff was responsive and helpful.
- ∴ The technology piloted was promising and intend to move forward with implementation in other courses.
- ∴ The instructors were pleased with the experience and will continue to provide their tests through Webassessor™.
- ∴ Faculty would like to see some enhancements in Webassessor™ to make grading short answer, matching, and fill-in-the-blank type questions more convenient.
- ∴ For some students who do not have easy access to computers where updates or software can be loaded, as with deployed military students, an optional method for testing may need to be implemented.

Conclusions and Next Steps

Reasonable criteria for success for this pilot include (1) effective testing of students in Pennsylvania and across a broad geographical reach, (2) easy completion of all setup steps for the examination process, (3) launching and completing all exams, (4) constant monitoring and deterrence of security problems, (5) the detection of actual security problems when they occur, (6) student satisfaction, and (7) faculty/staff satisfaction. Considering both the positive and negative results, the following letter grades could be assigned:

Effective Testing Anywhere	A
Easy Completion of Setup	C
Launching/Completing Tests	B+
Security: Deterrence	A
Security: Detection/Handling	A
Student Satisfaction	C
Faculty/Staff Satisfaction	B

According to these criteria the pilot can be considered very successful. Despite some of the technical issues students discovered during the launch process, each student was able to launch his or her exam(s), complete the exams, and receive valid scores. Security problems were rare. Despite the constant and stringent detection methods (or perhaps because of), the large majority of students completed the tests without any security issues. When a student did attempt to cheat, it was discovered immediately and dealt with effectively.

Reasonably, the faculty and World Campus Learning Design staff felt that with the ongoing modifications to the registration environment, the addition of a camera placement view, and with modifications to the student instructions, Online Proctored Testing through Webassessor™ will continue to improve rapidly as a sound and valid method that provides student convenience, satisfaction and a secure testing environment that helps assure academic integrity.

Known software problems with Webassessor™, while few, were corrected during the pilot since the software-as-a-service, or SAAS, model allowed the immediate fix of bugs and other problems. For subsequent pilot testing, new software features will make the setup and enrollment process easier and more foolproof. Tests will be easier to launch. It is expected that the rate of support calls during the early stages will be reduced from 82.7% to a goal of under 10%. The goal is reasonable; the pilot results indicated that as students gained experience with Webassessor™ the number of support calls were significantly reduced. This result will continue to improve as these students take their next courses.

In addition to the demonstrated advantages, in a time of rising fuel costs and other energy issues, KRYTERION's Webassessor™ provides a "green" solution that allows students to take their course exams at home. There is no need to spend the time and trouble of going to a testing center to take an exam or to find and sign up someone to proctor the exam.

This pilot represents an important demonstration of what has been previously thought to be impossible: the high-stakes testing of students anytime, anywhere, even in a person's own home. It marks a watershed moment in the history of technology-based testing, whether in the distance education marketplace or anywhere else high-stakes tests are administered.

Addendum to White Paper:

USING MULTIPLE ONLINE SECURITY MEASURES TO DELIVER SECURE EXAMS TO TEST TAKERS

Background

From October 2008 through December 2008, KRYTERION conducted a second pilot of Online Proctored Testing for several clients. This second pilot had three purposes — (1) to determine the affects of changes to the registration, test launch, and proctoring procedures and technology, (2) to replicate the security findings of the first pilot, and (3) to extend the exciting results to more testing programs, more published test titles, more test takers, and more administered tests.

The major differences between Pilot 1 and Pilot 2 are in Table 1.

Table 1
Differences in Scope between Pilot 1 and Pilot 2

	Pilot 1	Pilot 2
Number of Testing Programs	1	7
Number of Published Test Titles	6	43
Number of Tests Administered	84	602
Number of Students	30	181

The testing programs participating were three certification programs and four distance education programs:

- ∴ Western Governors University (Distance Education)
- ∴ The Pennsylvania State University World Campus (Distance Education)
- ∴ The American Association of Poison Control Centers (Certification)
- ∴ The National Institute of Pension Control Administrators (Certification)
- ∴ Omniture (Certification)
- ∴ Thomas Edison State College (Distance Education)
- ∴ University of Toledo (Distance Education)

Distance education organizations participated in the second pilot to continue to evaluate KRYTERION’s Online Proctored Testing solution as a secure and easy-to-use system for the

testing of their students. The certification programs participated mainly to evaluate whether Online Proctored Testing could help them supplement their existing test delivery model with test taking in the home or local office. The certification candidates who participated in the pilot lived too far from existing testing centers.

Results of Pilot 2

Security Issues. The measure of most interest is the number or percentage of security problems detected and handled. There is a common and strong interest as to whether an online-only testing system can employ enough security measures that an organization would consider it secure. During Pilot 1, with 84 tests administered, only two security incidents (2.38%) occurred. During Pilot 2, there were 20 incidents, or 3.32% of the total. In both pilots, the number of incidents was very low and did not change significantly from Pilot 1 to Pilot 2. Compared to rates of security incidents in other educational testing contexts and in other high-stakes testing contexts, rates below 5% would be considered extremely low and indicate that strong security measures were in place.

It is important to note that certified online proctors detected and handled all security occurrences immediately. The general method used for a security incident was to pause the test, and send a warning message asking the test taker to cease the inappropriate behavior. When the test taker complied and acknowledged the warning, the test resumed. All tests were completed. Proctors who observed these security issues forwarded notices on to the respective testing program.

Technical and Procedural Issues. By far, the bulk of issues that students experienced during Pilot 1 were technical or procedural, making it difficult to launch and complete the exam. Examples included failure to provide an enrollment photograph or to schedule the tests properly. It was felt that improvements to KRYTERION's administration system, Webassessor, as well as better training of testing program staff and students, would have a positive effect on the rate of many of these issues.

The improvements had the predicted effect. Overall, technical and procedural issues declined by 40.8% from Pilot 1 to Pilot 2. There were decreases in all sub-categories. For categories with less frequent problems, the improvements were smaller: biometric enrollment problems declined 2.85%; registration issues declined 2.10%; and system issues declined 2.35%. Areas that demonstrated larger improvements included the test launch process (19.77% decline) and Webcam use (12.02% decline).

Conclusions

The results of Pilot 2 provide additional evidence of the effectiveness of KRYTERION's Online Proctored Testing, and extend the application to the area of certification testing. The most important finding from Pilot 2 is that the very low percentage of security incidents continues.

The application of multiple, new security technologies is effectively deterring cheating for students in distance education programs and candidates in certification programs.

The rate of technical and procedural issues is declining rapidly with the addition of software enhancements and training programs for test takers. KRYTERION expects that the percentage of these types of issues will continue to decline in 2009 to an acceptable target of 10% or lower.

Based on the results of this second pilot, KRYTERION's Online Proctored Testing model remains a viable, cost-effective, and convenient model for all high-stakes testing programs, and one that provides significantly improved security compared to other high-stakes test administration models.