

Development and Integration of Freely Available Technology Into Online STEM Courses to Create a Proctored Environment During Exams

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This article presents the experiences of a Chemistry professor who has implemented an online instructional methodology that utilizes freely available technology allowing verification and real-time proctoring of online assessments. The developed online proctoring methodology incorporates the direct use of students' smartphones and devices during online assessments. Instructor prepared videos that visually illustrate an "online assessment rubric" and how students may meet the rubric by fully showing their "workspace" when taking an online assessment appear to play a major role in the successful implementation of this methodology with an objective that includes the prevention of academic dishonesty. Advantages of the flipped classroom format, daily proctored quizzes, use of document camera, multiple screens, and breakout sessions also played a role. Evidence of academic dishonesty, its prevention, along with mistakes and best practices in creating a viable proctored academic environment when using Webex, Teams, and Blackboard was observed.

Keywords: testing, proctored tests, distance education, online education, curriculum

INTRODUCTION

This paper through an active-research study suggests an effective online assessment method to proctor synchronous online courses with roughly twenty students. It was designed by a Chemistry professor who has been teaching via flipped classroom instruction for the past ten years. Like myself, many professors at public and private universities and colleges have been thrust into the realm of online instruction due to the Covid-19 pandemic. Use of Zoom and other video conferencing software have made the transition to online lecture portion of the course while not smooth at least manageable. After a brief learning curve, skills and experience gained from f2f instruction directly benefit the transition to synchronous (i.e. the course is taught at specific days and times) online instruction when using video conferencing software. However, the transition to online assessments from experience has been fraught with difficulties and inconsistencies in not only the creation of online assessments but also enforcement of academic integrity in the online course. This is especially true with universities such as mine that do not purchase academic integrity commercial tools such as Respondus software. In such a situation, it is an unwritten directive of the instructor to create online assessments and insure student academic integrity in his or her online courses. To achieve this directive an extensive search for guidance from the best practices found in literature, advice from a learning management system, and accrediting agency guidelines were investigated. Herein lies the inherent problem this paper attempts to address: in the absence of university financial support how can a f2f instructor create online assessments (especially in a problem-based STEM course) while upholding academic integrity of

students? The solution presented in this paper consists of an online assessment routine (OAR) which was followed religiously during all daily quizzes and exams in a synchronous (i.e. all students meet at the same time) online format of instruction. The online courses consisted of introductory and advanced Chemistry courses of roughly twenty students in each course.

PREVALENCE OF ONLINE CHEATING

The lack of student academic integrity manifests itself both online and in the f2f classroom. Watson and Sottile (2010) performed a study of 635 undergraduate and graduate students:

- 33% admitted to cheating in online classes
- 32% admitted to cheating in traditional classes
- 2% of online students were caught cheating
- 5% of students in a traditional class were caught cheating

Grijalva et al. (2002) essentially agree with Sottile in that typical data indicates students are no more likely to cheat online than in a f2f classroom. However, from personal observation this appears to not be the case in my transition to fully online instruction in both introductory and advanced synchronous online chemistry courses over the past two years. The opportunities to cheat in the online classroom are simply much more abundant in comparison to a f2f classroom with the instructor's eyes upon you the entire time. Just in the past semester I have observed four students cheating during online assessments and in addition have received a private chat message that was meant for a student. These are only a few of the instances of academic dishonesty I was able to observe, it is unknown how many instances of academic dishonesty I failed to observe in this timeframe. While cheating does occur in the f2f class I believe it impacts student learning in a more damaging way in the online classroom due to a multitude of opportune moments for academically dishonest acts to occur simply because the instructor's eyes are not present upon the student.

CREATING AN ONLINE ENVIRONMENT THAT UPHOLDS ACADEMIC INTEGRITY OF ITS STUDENTS

In the beginning of the pandemic in early 2020 many instructors like myself were thrust into a realm of online instruction. Video conferencing software in combination with synchronous offering of an online course has allowed the lecture component of f2f instruction to transition rather smoothly to online instruction. The only hurdles being a learning curve on incorporating multiple cameras including a document camera for students to be able to ask and watch problems being solved by the instructor. However, the creation of online assessments that uphold academic integrity is extremely difficult and a task with which there is little guidance. Guidance was sought from an accrediting agency, best practices from literature, and a learning management system for practical advice in creating online assessments that uphold academic integrity in an online STEM course.

Guidance From University

Due to declining enrollment and resulting absence of funds, my university offered no financial support in the area of purchased tools and protocols to prevent online cheating. This lack of attention may simply be since no such effort is deemed necessary by the accrediting agency, the Southern Association of Colleges and Schools Commission on Colleges (SACSOC). SACSOC distance education policy states the minimum requirement for accreditation on this issue is a username and password.

Guidance From Literature

It is difficult to find in the literature practical non time-intensive best practices to thwart online cheating. Much is like Cluskey et al. (2010) who proposed eight "control procedures" which are mostly common sense, practical, and good practices that would be beneficial in f2f or online instruction. Suggestions included clear communication and common exam controls. Prince et al. (2009) essentially found that more

proctoring with well-trained proctors was their recommendation for an improved online environment. Wellman (2005) and Ramaiah, P. (2014) wrote that proctored environments were far superior to unproctored online testing. Harmon et al. (2010) suggest for online courses with multiple choice exams that instructors modify their assessment design to aggressively use “strategic question shuffling tactics.”

Guidance From a Learning Management System (LMS)

Discussions with our LMS, Blackboard, technical support provided the following best practices to prevent online cheating. These practices included:

- Question Sets
- Test Availability Settings
- Due Date
- Show Test Results and Feedback to Students
- Randomize Answer Distractors
- Randomize Question Order
- Deliver Questions One-at-a-Time
- Prohibit Backtracking
- Password Protection
- Timed Auto submission

Initial attempts at reducing online cheating in my online Chemistry courses included all these recommended attributes from our LMS. This effort required many intensive hours and highly detailed work to create the pools of questions required to fulfill these recommendations. In the end the question pools had several errors. Realize with Chemistry assessments sub and superscripts are common. Scientific notation is also a necessity with extremely large and small mathematical answers. Units are also an important component of chemistry exams. Typical LMS's cannot accept scientific notation or units as numerical answers. Nor can they offer scientific notation ranges as answer choices. An additional complexity with an LMS is that question pools are separate entities in different sections of the same course. Therefore, when an error is found that same error must be attended to independently in each separate course's question pool. Errors resulted in regrading of online exams. This resulted in students who had previously received points erroneously becoming frustrated and upset. In the end, the exhaustive preparation efforts to meet the LMS recommendations stated above resulted in a high degree of student dissatisfaction and frustration with the randomized, question pool, online created assessments. Compare this student experience to that of a typical f2f exam student experience. During a f2f Chemistry exam all students take the same exam at the same time. Question pools, randomization, and other complexities are not used or needed. The reason for that is the instructor's eyes are upon the students taking the f2f exam. In order to create an online environment that allows a typical f2f exam to be given, the instructor's eyes must be present on the student, their workspace, and their screen during the entire assessment. A solution to this dilemma is the online assessment routine (OAR) presented in this paper.

Online Assessment Routine (OAR)

The OAR affords the instructor to give the same exam to all students at the same time and proctor all students just like during a typical f2f exam with essentially the only difference being the instructor cannot “walk around the room” so to speak to monitor student workspaces for illegitimate behavior. During online assessments the instructor must always be able to see each students' hands, workspace in front and surrounding each student, and each student's computer screen being used to take the exam. This proctored assessment environment does not include viewing each student's face. The reason for this is two-fold. The act of a student logging into the course to take an assessment identifies the student through submission of their username and password according to SACSOC as a minimum method of student identity verification as stated earlier. The second reason a student's face cannot be seen is because the webcam is not being used by the instructor to proctor the exam. Instead a student's smartphone or smart device allows the instructor to proctor the entire assessment event.

Below is the developed OAR provided to students which includes technology and software requirements. It also includes what students can and cannot do during an online assessment.

“Online Assessment Routine (OAR)”

- *Please note that every Webex class period is recorded. Recordings are used for academic integrity both during and after online assessments. At the discretion of the instructor academic penalties may range from a friendly warning to grade penalization. Understand upon review of a recording, penalization may occur after a grade has been posted in Blackboard. During an online assessment, students may not wear smart watches. The instructor proctors all online exams. At the discretion of the instructor, the instructor may interrupt a student if any element of the rubric appears to not be followed. Students are expected to start the exam and quizzes on time. Late starts may be penalized up to 3 points per minute late. The start time commences after the code has been provided by the instructor. This encourages class to finish on time. Like a typical face to face class period, students are reminded to visit the restroom before class starts.*
- *Each student must have reliable internet with ample bandwidth (perform an internet speed test and you should have roughly a minimum of 30Mbps download and 20Mbps upload speeds).*
- *Each student must have their own quiet place to work.*
- *Each student must have their own (i.e. independent from other students during a Webex meeting) pc/laptop with a working webcam.*
- *Each student must have their own smart phone or smart device like an iPad with a working camera.*
- *Each student must have operational software (Webex Meetings, Microsoft Teams, Outlook, and Word) installed on their laptop/pc and on their smart phone/device.*
- *When taking an online quiz each student enters the Webex meeting using their phone or smart device and continuously shares video of their workspace with the camera while simultaneously taking the quiz on Blackboard with their laptop/pc. Upon completion of the quiz and in order to fully receive participation/attendance points associated with the assignment students must use their pc/laptop for the remainder of the Webex meeting sharing video through the pc/laptop webcam and/or continued sharing their workspace video feed with their smart device.*
- *When taking an online exam each student enters the Webex meeting using their phone or smart device and continuously shares video of their workspace with the camera while simultaneously taking the exam on Blackboard with their laptop/pc. Upon completion of the exam, each student uploads their exam work to Blackboard.*
- *The workspace is the region where the student is writing along with the screen of the laptop/pc which the assessment is being taken. The region where the student is writing may contain the following: writing instrument, eraser, instructor assigned calculator, three blank pieces of paper, periodic table removed from course manual (with no writing on front or back), and instructor permitted equation sheet(s) from the manual (with no writing on front or back.) The course manual or any other papers may not be present in the workspace. Please ensure student hands and the laptop/pc screen where the assessment is being taken is shown continuously in the video feed. Students do not need to show their face, head, etc. but should take care to never leave their video feed during an online assessment. Please see the introductory video for visual examples including step by step procedures to create the requested workspace video feed.”*

The online assessment routine (OAR) is detailed and rather lengthy hence a video short was created to allow students to visualize the OAR in action. The video conferencing software Webex was chosen over Microsoft Teams because of the on/off control of the private chat feature in Webex. In order to turn off private chat during assessments with Microsoft Teams private chat would have to be turned off for all Teams for an entire organization. Zoom was also not chosen but for privacy concerns. Mills-Senn (2015) found that students often struggle with unfamiliar technology which makes training all the more important. Hence, before the semester starts the OAR is provided to students along with an extra credit

OAR practice opportunity. This opportunity also serves as a meet and greet for the students and instructor. In addition, students are informed well in advance that the first day of class will have an online assessment in which the OAR will be enforced. This first day assessment consists of a simple question for example stating a date of birth with the sole purpose of allowing the instructor an opportunity to provide feedback to the student as to the degree with which each student is fulfilling the OAR during the initial assessment.

CONCLUSION

Over the past two years the grade distributions of f2f and my online Chemistry courses when using the OAR are essentially indistinguishable. Whether use of the OAR has decreased cheating is simply not possible to measure. However, use of the OAR has allowed the direct use of f2f exams in my online Chemistry courses without affecting course grade distributions. Possible shortcomings where a student could cheat while following the OAR include

- a student could “pin” another student’s video feed and see their answers; however, this may be seen by the proctor and would also be recorded,
- a student could have a 2nd screen outside of their video feed and this 2nd screen is used to view pictures, internet search results, communicate with other students, etc.

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