

Some countermeasures to deter the posting of exam questions on answer-sharing services

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There are various low-cost online services that students use to get real time academic assistance. These services sometimes refer to themselves as online “tutoring”. In reality, their “tutoring” is little more than homework answers offered as a gig service. Graduate students, advanced undergraduates, and even some professors around the world supplement their incomes by providing answers to questions in real time. These services are basically analogous to Uber: if Uber connects you quickly to someone with a car, online “tutoring” services connect you to a person who can do your homework for you.

Prior to the coronavirus pandemic, these services were essentially a nuisance to teachers. Their willingness to profit by subverting the value of academic assignments was outrageous, but since the services were used mainly for relatively low-stakes homework assignments, their potential to undermine the standards reflected in course grades was minimal. That changed when the pandemic forced nearly every school in the world abruptly to move their courses and exams online, since these services are now useful not only for low-weight homework assignments but also for high-weight exams that are often unproctored.

In spring 2020, the math department administered unproctored exams online through the Canvas and MyMathLab platforms, so we came up with various strategies to deter the use of online answer-sharing or tutoring services. Our thinking was that our ability directly to prevent the use of such services was limited, but we could increase the burden of using the services and make them less useful to students. Our strategy consisted of the following elements:

- Include in each question multiple copyright notices that clearly identify the material as an exam, and position the copyright notices in ways that are difficult to remove.
- Create many different versions of each question to be served randomly.
- Reduce the amount of time that students have access to a given question, by breaking a longer exam into multiple portions if necessary.

We will discuss each of these in turn:

Include copyright notices and position them so that they are hard to remove

Liberal application of notices such as “Rutgers Math 151 Exam © 2020” to a question makes it harder for students to post these questions – but only if the notices are applied in the right way.

Online services are run by large companies. They are often publicly traded. They have investors, a legal department, and a public reputation to worry about. Regardless of what students actually use these services for, a major company cannot afford to be seen as intentionally contributing to cheating on exams, or assisting in widespread copyright violations. Therefore, these companies often have internal codes of conduct that prohibit their employees from providing assistance on exams, and that require the

company to remove any copyrighted material from its site. A tutor who sees that they are being asked to help on a copyrighted exam may decline to answer the question for fear of losing their job.

To complicate the process of posting a question on an online service, it is important to think about how a student would post such a question. Usually, students “screen shot” the question, and use a rectangle crop tool to crop out extraneous parts of an image. In fact, some online services have phone apps that come with such a rectangle crop tool, which make it easy for students to send material *inside* a bounding rectangle. Therefore, to ensure that this tool would capture the copyright notice, it is important to position some of the copyright notices in such a way that any rectangle that contains the entire question also contains the copyright notice. The following images are from an actual math exam that was administered in Spring 2020. While we felt that it was important to place a large notice at the top of each question, we did so recognizing that such notices on their own would be ineffective to defeat the crop tool. Observe that smaller notices were placed strategically throughout the question, and that it would be impossible to draw a single rectangle that includes the entire question but also omits the copyright notices:

Question 3

4 pts

RUTGERS UNIV. OFFICIAL MATH 151 SPRING FINAL EXAM © 2020

Which of the following is equal to $\frac{d}{dx} \int_2^{x^5} (1+t^2) dt$?

(Select only ONE answer): Rutgers Exam © 2020

$1 + x^2$

Rutgers Exam © 2020

$x^5 + \frac{x^{15}}{3} + C$

Rutgers Exam © 2020

$\left(x^5 + \frac{x^{15}}{3}\right) - \left(2 + \frac{2^3}{3}\right)$

$1 + x^{10}$

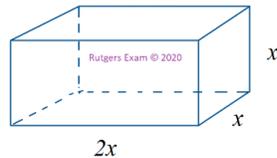
$(1 + x^{10})(5x^4)$

Question 5

4 pts

RUTGERS UNIV. OFFICIAL MATH 151 SPRING FINAL EXAM © 2020

A rectangular box has the proportions shown in the figure, so its height and depth are equal, and its width is twice the height. Rutgers Exam © 2020



The box is getting larger in such a way that it keeps these proportions while its volume increases at a rate of $8 \text{ m}^3/\text{sec}$. Rutgers Exam © 2020

At what rate (in m^2/sec) is the surface area increasing when the height of the box (x) is 2 meters? Rutgers Exam © 2020

You may use the fact that a box of height x with the proportions indicated above has a volume of $V=2x^3$ and a surface area of $S=10x^2$.

Your answer should be accurate to at least **one** decimal place. Do not include the units in your answer. (E.g., if your answer is $17.9 \text{ m}^2/\text{sec}$, enter 17.9 in the box. If your answer is 17.0, you may enter 17 without a decimal.)

As a best practice, we found that it makes sense to make the copyright notices (1) small (using a subscript or superscript font), and (2) purple. Ideally, we don't want honest students even to realize that the notices are there, because the goal is to make *dishonest* student think twice about submitting the question and realize that removing the copyright notices is going to take up valuable exam time. Using small print in a color that contrasts with the black print of the question makes the copyright text less confusing for the student. And purple seems to be a less menacing color than red, so it may be less intimidating to those honest students to whom the notice is not directed.

Use multiple versions of a question

Online services often post answered questions for their subscribers to search for, text-recognition technologies make even photographed or handwritten questions easily searchable. Using multiple versions of a question serves two purposes:

- It makes it less likely that other students will be able to use an answered question that they find on the internet.
- It helps to identify the student who posted the question for the purpose of bringing discipline proceedings, in the event that deterrence efforts have failed.

Observe question #5 above in the figures above. Although it is not apparent from the image of this question, there were actually 20 different versions of this question. Had we been less particular about

the simplicity of the numbers, Canvas would have allowed us automatically to create up to 200 versions of this question. If a student searched for this question on the internet, it is unlikely that they would have found their exact version of the question, so the answer would have been useless to that student.

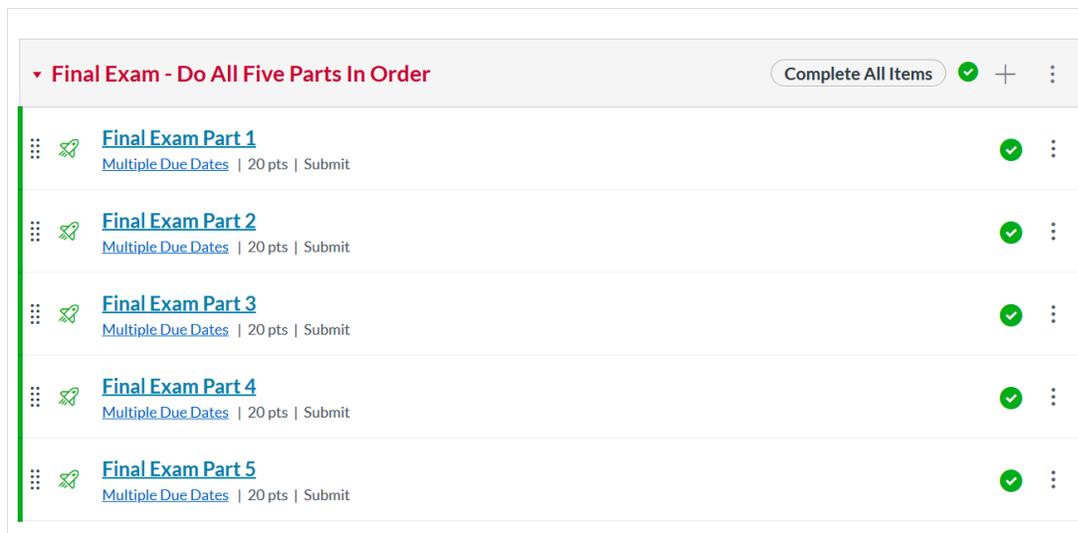
Additionally, if a student does post a question, the rarity of the specific combination of numbers in the question can help to identify that student later. For an example of this, see the case study at the end of this paper.

Break the exam into several short sections to reduce the amount of time that students have access to each question

Getting an answer from an online tutor takes some time. By limiting the amount of time that students have access to a given question, it is likely that a student who seeks help from an online tutor will run out the clock before the answer arrives.

Canvas allows instructors to prohibit backtracking – i.e., a switch can be set that requires a student to answer the current question before moving onto the next one, and that prevents returning to questions that have been answered. For our spring exams, we felt that using this feature would have forced students to take exams in a very unnatural way, so our compromise position was to break our final exam into five 30-minute segments of five questions each. (To ensure that students had time to move from segment to segment and still finish within three hours, we decided to make our exam a total of 2.5 hours instead of three hours.)

Here is a screenshot of the Canvas module that we used to administer the Math 151 final exam in Spring 2020. Not only does the module tell students to do the parts in order; Canvas has the ability to enforce this order:



A Case Study

We gave the Math 151 exam on May 7, 2020. Student had from 7am until 7pm on that day to complete the five 30-minute segments of the exam. They were required to complete the parts in order, and that requirement was enforced by Canvas.

We hired proctors to monitor internet sites during the exam by searching in real-time for our exam questions. During the exam, we found no instances of posted questions. After the exam was over, a deeper search found two questions that had been posted. We considered this an improvement from our midterm exam; on the midterm, we did not employ the techniques described here, and found dozens of our questions on internet sites. So, anecdotally, we consider these techniques to be effective.

One of the final exam questions that we found on an online service is worth noting, because it suggests the effectiveness of these techniques. Question #5 in the figures above was found on a tutoring service. We found it in a handwritten form – presumably because the copyright notices made an image of the question unusable on a service that followed a copyright policy. We estimate that the inability to submit even a cropped photograph of the question cost the student approximately five minutes. Moreover, when we advised the service of the posting and asked them to send us their activity logs relating to the question, those logs showed that nearly half an hour passed between the time that the student posted question and the time that it was answered.

Additionally, we were able to use the randomized values in this version of the question to narrow the set of students who posted it down to 30 students (out of approximately 400 who took the exam). When we received the activity logs, we were able to positively identify the student who posted the question, and we reported that student for an academic integrity violation. (We also learned that the time on that section of the test ran out for this student 20 minutes before the online tutor provided the student with an answer, so that student's attempt to obtain outside help ended up being ineffective – probably due to the fact that we broke the exam into 30-minute segments.) While we find no joy in referring a student for discipline, we do believe that when students realize that there are many anti-cheating measures working behind the scenes – some of which they are not even aware of – this fact will tend to deter cheating and will also increase honest students' confidence in the overall fairness of the exam.