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The COVID Cloud's Ag Lining

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My first concern for academic integrity, as I imagined the task of assessing 800 students in the Fall 2020 (September - December) semester offering of CHEM 201, one of the University of Calgary's (U of C) first-year university general chemistry courses, was how to hold fair exams. After attending many meetings addressing academic integrity (see also Raje & Stitzel, 2020), I was convinced that a completely open-resource approach to the course – open-resource with the exception of consulting other people during exams – would be the best model for CHEM 201. Such a course would help students learn how to research "the answers" for themselves and also how to cite these sources.

I taught at the U of C during the Winter 2020 (January - April) semester. I prepared two versions of that course's final exam, and several cases of academic misconduct came to light because student responses did not answer the question asked on that student's paper, but instead answered a question from the other exam version. My experience in April 2020 revealed, among other things, the challenge of distinguishing between the potential academic misconduct of a student copying material directly off an online resource (the extent to which this type of copying, without citation, is not allowed on an exam was not well-established for the April 2020 cohort), and the very serious academic misconduct of one student copying answers from another student, one who had copied material directly off an online resource. The exam questions were original in their creation and the exam itself had been open-resource, so while students were free to consult their notes and search the internet for support, the only provenance of the answers from the wrong version of the exam would have been classmates. From Friday, March 13, 2020, when the U of C changed from face-to-face to online courses, until the exam period in April, there had been limited time to create new online norms or to support students' online research skills and, in combination with many other factors, the result was academic misconduct.

As the Summer semester faded and the Fall semester approached, I believed that the traditional high-stakes exams were too much pressure for the CHEM 201 teaching team to hold and for students to contemplate in these unprecedented times. Therefore, an unprecedented course outline with a grade breakdown of ~10% for each item of coursework – whether it was an online laboratory report, tutorial work, or an exam – was written and approved. In CHEM 201, there would be no low-stakes assessments, but also no high-stakes assessments. Every piece of coursework was written to take approximately the same amount of time and involve the same amount of effort. Moreover, students' lowest tutorial score and lowest laboratory score would be

excluded from the overall course grade calculation, so students who were ill or who experienced family tragedies were not pressured to complete additional work once they were able to resume their studies. It was hoped that this flexible course outline would minimize student stress and avoid placing students in positions where they might make poor decisions concerning academic integrity. Both online laboratory activities and online tutorial activities were designed to require only as much time as was Registrar-scheduled; for example, no work was to be turned in a week after the activity was held. Attention then turned to the exams.

When thinking about how to hold the two midterms and a final exam with academic integrity, I remembered how the insect pheromones synthesized in some U of C undergraduate laboratory experiments (Henrick, Carney, & Anderson, 1982) could be used in mating disruption in agriculture (Lance et al., 2016). When the pheromone of an insect is spread in trace quantities over an entire crop, insects of the opposite sex can no longer locate each other. In short, by flooding the system with a chemical used for communication, communication broke down. In a similar way, I hoped to create so many exam versions that attempts by students to collect them all and collaborate in unauthorized ways would prove challenging during the exam's time constraints.

My co-instructor agreed with this plan, and we developed exam questions for the midterms. All exam questions had some feature that allowed for the creation of many versions, and all version possibilities were collected in a single document that was used to initiate the creation of all the exam versions. That one version of the exam with all the question options would be copied and those copies were given distinct filenames, then the first question on each of those files would be altered to ask about a single item. For example, the first exam question might read "What is the ground state electron configuration for Ti^{3+} / V^{3+} / Cr^{3+}?" in the original exam document and this would become:

> "What is the ground state electron configuration for Ti^{3+}?" in the Version 1 file
> "What is the ground state electron configuration for V^{3+}?" in the Version 2 file
> "What is the ground state electron configuration for Cr^{3+}?" in the Version 3 file

Those files in turn would all be copied two or three times, and the second question altered; this process would proceed until different options had been used for all exam questions. The first midterm had five questions in total and 34 versions were made; the second midterm had six questions in total and 37 versions were made.

These files then had to be distributed. The student class list could be sorted by first name, by last name, or by ID number, and one of these sorting methods was selected for each exam. Student e-mail addresses were copied from the class list in batches, and mass e-mails were written with students blind carbon-copied. For each new e-mail message, the exam paper's filename had to be changed to a generic "First Midterm" or "Second Midterm" so that a detailed filename would not allow students to match versions. The instructions for writing the exam and its submission were

in the e-mail message, and the exam paper was attached. In anticipation of grading, students were manually assigned to their class list-based groups in the U of C's learning management system, Desire2Learn (D2L). This would allow members of the CHEM 201 grading team to just click from one student to the next while grading, instead of searching for each individual student's submission. Ultimately, the creation of the e-mail messages and the D2L groups took several hours. Some students had to be removed from their original batches and assigned to new ones, due to scheduling conflicts caused by the CHEM 201 midterms being held outside of class time.

The U of C requires instructors to provide accommodations to students who are in other time zones, as we have students from all around the globe taking our online courses. This meant that the midterm exams were released over a 27-hour period for the first midterm and a 40-hour period for the second midterm. The U of C guidelines also instituted an additional 50% of the set exam time in case of technical difficulties. Each midterm was designed to last 80 minutes, with 40 minutes additional allowance for difficulties uploading to the system.

In contrast with the two exam versions that were traditionally used for the two midterms in face-to-face settings of CHEM 201, the creation of approximately three dozen versions of an exam was extremely time-consuming. Instead of exams being distributed in person in about fifteen minutes before an exam room was opened to students, hours were devoted to creating e-mails with the correct version associated with the correct batch of students. Instead of spending two or three hours invigilating students writing in a few large rooms at the U of C, someone from the CHEM 201 teaching team had to be available by e-mail during the entire time the exams were being completed. Instead of sorting the exams quickly into "Version A" or "Version B", traditionally distinguished with coloured paper or some identifying front-page image, students had to be manually assigned into different groups on D2L. In short, time that could have been spent answering student queries, creating sample practice materials, developing questions or exercises for lecture, laboratory, or tutorial, were instead devoted to creating this complex system revolving around more than thirty exam versions. The exam versions, due to their creation method, might also be identical except for the very last question. There was considerable concern that the exam could be compromised at any time over the broad range of exam release times. There was no way to control or monitor students' use of the two hours provided, to prevent students from using more than 80 minutes to answer exam questions. The exam questions' creativity was limited partly by the need for them to readily generate multiple versions, but also for fear of copy/paste errors.

These difficulties do not, I believe, overshadow the benefits this system offered to students, who had extensive opportunities to learn how to perform targeted internet searches and to cite their sources properly. For example, the references for face-to-face semester laboratory reports had been identical from one student to the next: the laboratory manual, the technicians, students' lab partners, and perhaps a journal article consulted for a specific constant. This semester, students

were encouraged to explore chemistry concepts on their own. Students should have found that there are many online resources that are suitable for CHEM 201 purposes, that some resources are deemed better (more reliable, more specific) than others, and that even reliable websites have their limitations. Some course exercises were even designed to showcase that online searching can lead to dead ends! It is hoped that students were able to use those research skills under the time constraints of each midterm exam.

The exam-manufacturing process did compete with student queries about chemistry, but it was important to address issues concerning academic integrity with as much due diligence possible. It was vital that the CHEM 201 teaching team provide exams that students could write using their research skills and without engaging in academic misconduct. I choose to see the silver lining of the COVID cloud; I believe that students this semester recognized that the teaching team made the effort to address academic integrity throughout all course components. I also believe our students developed research and citation skills that should stand them in good stead, in both future online courses and in-person courses, when face-to-face courses resume.

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