Current References: Academic Integrity in STEM during the pandemic

We at the Office of Science Education have perused academic publications in STEM that focus on academic integrity during the COVID-19 pandemic and determined that these articles, grouped by the following topics, may be of interest to instructors and lab coordinators in the Faculty of Science.

Ideas for writing exams and exam questions

- Vary multiple-choice question format and incorporate academic integrity pledges
- Alter the units and values in exam questions to reduce cheating
- Shift types of questions and frequency of assessments
- Use question banks to vary content of exams

Potential assessments other than multiple choice and short answer

- "High impact" writing assignments assess higher-level learning
- Virtual oral examinations can personalize learning
- Take-home exams can test higher-order thinking
- Concept maps have limitations as a final assessment

Other ways to reduce cheating and plagiarism

- Understand the ways that students in your class could potentially cheat
- Consider the role of time allotment on student anxiety during remote exams
- Focus on positive aspects of learning rather than penalization
- Plan assessments with an awareness of students' use of file-sharing sites (e.g. Chegg)

Discipline-specific training for citation formats and understanding plagiarism

- Create STEM-focused citation training with librarians
- Include discipline-relevant citation training during students' first years

Please note: These articles were located with the help of Librarian April Colosimo and read by members of the Office of Science Education team. It is not our intention to endorse these particular articles, but rather to give you a sense of current research on this topic.

Raje, S., & Stitzel, S. (2020). Strategies for effective assessments while ensuring academic integrity in general chemistry courses during COVID-19. *Journal of Chemical Education*, *97*(9), 3436-3440. https://doi.org/10.1021/acs.jchemed.0c00797

Summary: Rates of cheating on quizzes and exams increased when delivered through the Learning Management System in a large first-year Chem class. Cheating involved students posting questions to 'tutoring' sites: primarily Chegg, and also ClutchPrep, CourseHero, and Justdomyhomework. Strategies used to prevent/discourage students from using 'tutoring' sites resulted in final exam performance scores comparable to in-person, pre-COVID exam scores.

Utility: Significant for large classes where assessment types are limited because of class size.

Methodology: grade-based comparison pre-/post-intervention (Fall 2019 vs. Spring 2020); n=150 students (from 700+ student pool); two sample subsets analyzed (high and low performing students).

Findings: Useful strategies indicated with **.

(1) Prevent "backtracking" during assessment: this was discouraged by the authors' institutional Office for Students with Disabilities as a potentially discriminatory strategy. Similarly, current McGill Faculty of Science guidelines require that students must be able to review assessment responses before submission unless special permission is granted. For details, please see 3.2. "No review" myCourses Quiz Option of the assessment regulations https://www.mcgill.ca/science/files/science/assessmentregulationsfall2021_1.pdf and Section C.5 of Guidelines for Instructors and Students on Teaching, Learning, and Assessment (Fall 2021) which addresses "no-review" testing: https://www.mcgill.ca/tls/instructors/policies/guidelines-f2021.

**(2) Develop questions based on imaginary units and modified values of standard universal constants: Students who understand the concept can still answer the question, and it makes it harder for students to obtain an answer from sites like Chegg.

**(3) Add watermarks: Convert questions to images and add a watermark. Prevents students from quickly copy/pasting questions to sites like Chegg, and watermark makes it obvious they are cheating if image is uploaded to a 'tutoring' site.

Please note: If an instructor finds that assessment content has been posted on Chegg.com or other websites that facilitate cheating, they can contact the Student Affairs Office at discipline.science@mcgill.ca for details on how to best proceed.

Key words: first-year, undergraduate, assessment

Back to Menu

Reynolds, J. A., Cai, V., Choi, J., Faller, S., Hu, M., Kozhumam, A., Schwartzman, J., & Vohra, A. (2020). Teaching during a pandemic: Using high impact writing assignments to balance rigor, engagement, flexibility, and workload. *Ecology and Evolution*, *10*(22), 12573-12580. https://doi.org/10.1002/ece3.6776

Summary: The authors promote the use of "high impact writing assignments" as an effective and equitable technique to deepen student learning, engage students in course-related topics, and assess higher-level knowledge (i.e., through synthesis and analysis). They recommend the use of prompts that require students to create evidence-based arguments and/or defend their beliefs on topics that are interesting and relevant beyond the context of the course itself. Instructors are encouraged to work with writing experts in assignment design, to provide detailed guidelines, to include scaffolded peer review, to encourage metacognition, and to be focused in their grading. Academic integrity can be supported through using knowledge-transforming topics and the use of plagiarism-detection software.

Overview of the research methodology: A summary of evidence-based characteristics of effective writing assignments.

Strength: Concise but comprehensive information about creating writing assignments with an example to illustrate suggestions. Because students write multiple drafts and reflect on how they have changed their draft with feedback, students have fewer opportunities to use paper mills.

Weakness: While they note that peer reviewing is useful in large classes, the authors don't define a large class size. They do note that their assignment length is ~500 words.

Utility: This is a concise argument for and description of how to use writing assignments in large science courses.

Key words: Eli review, peer review, science education, STEM, writing pedagogy, writing-to-learn, academic integrity

Back to Menu

Nguyen, J. G., Keuseman, K. J., & Humston, J. J. (2020). Minimize Online Cheating for Online Assessments During COVID-19 Pandemic. *Journal of Chemical Education*, *97*(9), 3429-3435. https://doi.org/10.1021/acs.jchemed.0c00790

Summary: Presents strategies that effectively minimize cheating while addressing learning outcomes in the context of chemistry courses at an American university. Framed as an alternative to software and online proctoring, emphasizes "pedagogical and cost-effective" approaches.

Overview of the research methodology: Summary of strategies used by the author and colleagues with references to external studies.

Conclusions: Effective strategies for preventing cheating while addressing learning outcomes include higher-order thinking multiple choice questions; novel, higher-order thinking short answer questions; increasing assessment frequency; and academic integrity pledges.

Strengths: Provides detailed lay descriptions of strategies with reference to other studies. Focusses on student learning.

Utility: Some strategies may not be novel, but a useful resource for instructors.

Back to Menu

Lomness, A., Lacey, S., Brobbel, A., & Freeman, T. (2021). Seizing the opportunity: Collaborative creation of academic integrity and information literacy LMS modules for undergraduate Chemistry. *Journal of Academic Librarianship*, *47*(3), 1. https://doi.org/http://dx.doi.org/10.1016/j.acalib.2021.102328

Summary: Collaboration between CHEM and the Library to create learning modules focused on information literacy and academic integrity for first year undergraduates. Modules offered via Learning Management System.

Methodology: Analyzed use of five modules comprising videos, readings, examples, and quizzes on topics of scientific literacy/writing, academic misconduct, and citation. Targeted toward first year CHEM students (n=700+).

Utility: Insight into integrating library resources within science courses. Focus is on academic integrity in writing. Takeaways:

(1) It's important to provide students with awareness of, and guidance on, academic integrity before they accidentally commit plagiarism "[students need to be] explicitly taken through examples of common plagiarism cases and academic misconduct before falling victim to misunderstanding".

(2) Learning about academic integrity in first year can prevent a ripple effect of academic misconduct in subsequent years.

Key words: information literacy, academic integrity, LMS, first-year undergraduates

Back to Menu

Jamieson, M. V. (2020). Keeping a Learning Community and Academic Integrity Intact after a Mid-Term Shift to Online Learning in Chemical Engineering Design During the COVID-19 Pandemic. *Journal of Chemical Education*, *97*(9), 2768-2772.
https://doi.org/10.1021/acs.jchemed.0c00785

Summary: Focus is rebuilding classroom community online to maintain a supportive learning environment and to promote academic integrity for both first year and senior CHEM-ENG courses. Strategies to promote integrity focused on preventative measures: (1) reducing assessment-associated student stress and (2) giving students a sense of control to reduce likelihood of resorting to cheating.

Methodology: Analysis of grades for three student populations (n=1200 first-year course, n=35 and n=100 senior courses)

Findings: Useful strategies indicated with **.

**(1) Establish instructor presence in the online course to motivate students and discourage cheating.

**(2) Reduced final exam weight.

**(3) Tested examination procedure with students so students could get used to the testing system before the final exam.

(4) Smart Exam Monitors (senior population of n=35 only, form of proctoring)

Utility: Broadly applicable ideas that focus on positive aspects of learning rather than penalization. Takeaways:

(1) Give students options and choices to give them a sense of control and maintain engagement (reduce temptation to cheat)

(2) Focus on building trust and instructor presence to support learning (reduce need to cheat)

Keywords: first-year, senior, undergraduate, classroom community

Back to Menu

Dicks, A. P., Morra, B., & Quinlan, K. B. (2020). Lessons Learned from the COVID-19 Crisis: Adjusting Assessment Approaches within Introductory Organic Courses. *Journal of Chemical Education*, *97*(9), 3406-3412. doi:10.1021/acs.jchemed.0c00529

Summary: The authors (at University of Toronto) describe their switch from in-person, written problem final exams to remote assignments in three introductory organic chemistry courses at the end of the Winter 2020 semester. In two of the courses, multiple choice problem-based questions were given via their LMS Quiz tool, while a smaller course continued with written problems for which answers were uploaded. In addition to sharing the types of revised questions used, they demonstrate that there was no significant increase in grades compared to earlier course assessments completed before the pandemic forced a switch to remote learning for the end-of-term.

Research methodology: Primarily a description of how the authors changed their assessments: types of questions, mode of delivery including the platform, scrambling of questions, access and completion time, and inclusion of an academic integrity statement for students to "sign". For one course (~400 students) they show the average difficulty and discrimination index of their multiple-choice questions as well as a comparison of the grade distributions on their two in-person tests versus the remote final assignment.

Findings: The change to a multiple-choice question format was largely successful in giving an equivalent assessment of their students and, under their conditions, there was little evidence of cheating both in the courses that switched to MC questions and the smaller one that used written answers that were uploaded. They note that the workload of making the assessment change was mitigated by the assistance of TAs in question design, and that, in the future, they would rely on question-and-answer randomization only (multiple versions of questions did not appear to be necessary as an additional academic integrity tool and that it was difficult to make versions that were comparable in difficulty).

Strengths: Examples multiple choice questions that test students' mid-to higher levels of knowledge as well as what can be done to increase academic integrity for multiple-choice questions (i.e. randomization). Clear, detailed description of how the assessments were given in terms of platform and accessibility

Utility: Resource for writing challenging multiple-choice questions.

Notes: Study completed at the end of the Winter 2020 term when there was a sudden switch to online assessment. Authors used restrictive timings on the assessments once started (similar times to in-person) that can aid academic integrity.

Key words: academic integrity, Covid-19, winter 2020, multiple choice questions, large classes, first-year undergraduate, second-year undergraduate, organic chemistry, Internet/web-based learning, testing, assessment, ethics, mechanisms of reactions, synthesis

Back to Menu

Duff, A., Zamecnik, A., Pardo, A., & Smith, E. (2020). The SEIRA approach: course embedded activities to promote academic integrity and literacies in first year engineering. Proceedings of the Tenth International Conference on Learning Analytics & Knowledge.
https://doi.org/10.1145/3375462.3375497

Goal: To determine if and how a discipline-relevant module on citing would benefit STEM students, particularly those using English as an additional language. The measure is success on assessments after engaging with this module.

Methodology: Focus is relationship between the behaviour of the students with respect to engagement with the SEIRA modules and students' results on their first assignment. Data sources:
(1) number of times students accessed each of the SEIRA modules
(2) scores of the first assignment (between 0 and 25)
(3) identifying the cases of plagiarism detected for the first assignment.

Findings: In general, engagement with the SEIRA module increased assessment scores. The study also analyses "clusters of engagement"—measuring how often and for how long students engaged with online learning modules.

Potential weaknesses for application in FacSci: Study conducted with engineering students. Pilot had less than 100 students in the study.

Utility: Significant for courses that include writing and citing sources. Provides guidelines for incorporating research sources in academic texts—this includes a focus on evaluating quality of sources.

Additional notes: an example of preventative, discipline-specific support rather than punitive follow-up. The "evaluation" component of citation education is really critical and it is great to see it included as part of SEIRA. Although SEIRA is described as "course embedded" the degree to which it is discussed in class and assigned rather than optional, encouraged, and included in the LMS, is uncertain.

Key words: student assessment, academic literacy, academic integrity, plagiarism

Back to Menu

Liberman-Martin, A. L., & Ogba, O. M. (2020). Midsemester Transition to Remote Instruction in a Flipped College-Level Organic Chemistry Course. *Journal of Chemical Education*, *97*(9), 3188-3193. https://doi.org/10.1021/acs.jchemed.0c00632

Summary: An evaluation of test-administering strategies used during the pandemic to address academic integrity issues and student anxiety during remote exams in a flipped organic chemistry course.

Research methodology: To reduce cheating, the exams were open book (including access to pre-lecture videos, worksheet solutions, and student notes). To ensure students were comfortable with the new process, a "demo" exam was offered with extra-credit given as an incentive with 100% student participation. In the first instance, the remote exam was unsupervised, and students given an 8-hour window (9am to 5pm Pacific Time). The second remote exam was limited to a 90-minute window for downloading, completing, and uploading the exam. In the final exam, students had a 210-minute window between 6 am and 11:59 pm and four versions of the exam were created and randomly assigned to students. Students completed a brief feedback form at the end of the course.

Conclusions: In each case, instructors suspected several cases of unauthorized student collaboration and solicitation of solutions through Chegg (a website that provides "expert" solutions to uploaded questions during an exam). No cases were suspected previously during face-to-face exams. Student anxiety heightened in the second and third exam conditions due to time pressure. For future remote exams, students recommend providing extended time to account for equity issues related to technology access and household distractions.

Strengths/weaknesses: For each exam condition, students signed the exam indicating their adherence to the instructor's explicit instructions on remote authorizations and collaboration during the exam and the university's academic integrity policy. Students were also not authorized to speak to anyone except their instructor about the exam content during or after the exam. There was suspected use of the Chegg website but no mention of whether these cases were investigated further.

Utility: Contains test-administering strategies for remote exams useful to McGill instructors who suspect student use of the Chegg website (presumably there would be more cases without these strategies).

Keywords: second-Year Undergraduate, Organic Chemistry, collaboration, cooperative learning, Internet/web-based learning, student-centered learning, remote testing, academic integrity

Back to Menu

Lewis, S. E. (2020). Chemistry Assessments through the Sudden Implementation of Online Instruction. *Journal of Chemical Education*, *97*(9), 3418-3422.
https://doi.org/10.1021/acs.jchemed.0c00697

Summary: Description of online assessments implemented by a team of general chemistry teachers during the pandemic; includes comparison of results with paper exams to alleviate concerns about cheating.

Research methodology: A case study of how online exams were administered during the pandemic in two general chemistry courses in a postsecondary institution in the US. Descriptive statistics for each exam were compiled for the 1499 students who took the final exam. Online exams were offered at the same day and time as originally scheduled exams using the university's LMS, Canvas. The focus is on the extent online assessments accurately measured student knowledge. To limit the extent of unintended student "collaboration", exams were given at a set day and time; question banks were developed so that students received variants of similar questions, and a remote proctoring software was used.

Findings/conclusions: Correlations show consistency between online exams and paper exams alleviating concerns about widespread cheating. A concern was found with reusing the same exam at a later date for students who missed the original exam despite efforts to keep the online exam secure. The generation of alternative exams for later dates is recommended. Remaining flexible for students who miss exams remains a challenge. The creation and curation of a large number of questions formatted for online administration developed across semesters may be helpful in meeting this challenge.

Strengths and/or weaknesses: The descriptive nature of the paper provides sufficient detail for implementing similar strategies in other contexts. There is nothing original in the implementation of online exams except the comparison with paper exams and the focus on consistency in measuring learning to inform future implementations.

Utility: Maybe of interest to general chemistry instructors at McGill.

Keywords: General Chemistry, online exams, pandemic

Back to Menu

Cotarlan, L. (2021). Contract cheating by STEM students through a file sharing website: a Covid-19 pandemic perspective. *International Journal for Educational Integrity*.
https://link.springer.com/content/pdf/10.1007/s40979-021-00070-0.pdf

Summary: An analysis of how the leading file sharing website, Chegg, is being used by undergraduate STEM students around the world for assessment and exam help.

Research methodology: (1) Analysis of the archive of homework questions posted in Chegg in five STEM subjects, namely, Computer Science, Mechanical Engineering, Electrical Engineering, Physics and Chemistry for the period before the pandemic (April 2019 to August 2019) and during (April 2020 to August 2020). In total, 3,050,372 exam style questions were posted before and 5,335,770 questions during. (2) In addition, a single typical day was analyzed for each period to calculate the number of questions receiving at least one answer. Analysis of questions shows that many are posted in the form of low-quality images demonstrating how quickly requests can occur and how challenging this is to police.

Conclusions: Results indicate a substantial increase (196.25%) in the number of exam-style questions being asked and answered as teaching and assessment moved online. Moreover, requests are being posted live and answered within the short duration of an examination. It is also observed that students are being sent questions on Covid-19 and that many of these are finding their way onto Chegg for third parties to answer on their behalf. Chegg's Honour Code claims that materials may be removed, or user accounts terminated if academic institutions contact them to open an investigation; however, there is little evidence this is happening. Given academic integrity breaches are becoming more common, a reconsideration of teaching and assessment methods is required, as well as some form of automated monitoring with immediate reporting to instructors if their assessments or exam questions appear to be found online.

Please note: In the Faculty of Science, if an instructor finds that assessment content has been posted on Chegg.com or other websites that facilitate cheating, they can contact the Student Affairs Office at discipline.science@mcgill.ca for details on how to best proceed.

Strengths: This study reports on blatant cases of contract cheating by STEM undergraduate students that calls for action from the entire academic integrity community. Only the Chegg website is reported on, so the problem is likely greater than it appears from this one study.

Utility: This study highlights the need for institutions to hold sites like Chegg accountable for academic integrity (as well as students), particularly since online teaching and assessment may continue after the pandemic.

Keywords: academic integrity, Chegg, contract cheating, online exams, pandemic, STEM disciplines.

Back to Menu

Dawson, P. (2020). ***Defending assessment security in a digital world: preventing e-cheating and supporting academic integrity in higher education*****. Routledge.**
https://mcgill.on.worldcat.org/v2/oclc/1157779909

Summary: This book explores state of the art in cheating, and what we gain and lose by approaches to stop cheating such as remote proctored exams. It begins with the premise that yes, we do need to take steps to both detect and deter cheating, and that this is difficult online. But we also need to be wary of surveillance, snake oil and the creation of a culture of distrust. Key argument is the need to balance academic integrity (positive, collaborative, educative) against assessment security (negative, adversarial, punitive).

Findings:

(1) Focus on assessment security alongside academic integrity
(2) Take an affordance-based approach to understanding e-cheating, and a principles-based approach to stopping it
(3) Perfect is the enemy of good, so aim for incremental improvements
(4) Build a culture of evidence and disclosure
(5) Resist assessment conservatism and assessment security theatre

Utility: Each chapter has a list of readings, suggestions or activities for follow-up. For example, the first chapter on cheating includes these recommendations:

- Familiarize yourself with your academic integrity landscape. At minimum this should include any academic integrity policies or procedures that are in place at your institution. Do you think these adequately cover e-cheating? Is their coverage of e-cheating forward-looking like the taxonomy, or is it instead focused on dealing with particular and current threats?
- Browse the International Center for Academic Integrity's website: www.academicintegrity.org/ It is important to maintain a strong grounding in academic integrity. At minimum, the Fundamental Values of Academic Integrity (Fishman, 2014) should be considered essential reading.
- Find out how to cheat at your institution. A likely first step by any potential cheating student at your institution will be to search 'how to cheat' along with the tools your organization uses. It's important you familiarize yourself with those approaches.
- Search the course codes for the classes you teach and a range of cheating-related terms, like 'cheat', 'buy', 'answers' and 'notes'. Many educators are shocked when they realize how much cheating is happening in public view. But be careful not to view your search results as comprehensive; it's likely that much of the cheating that occurs in your course is not indexed by search engines.

Back to Menu

Kamber, D. N. (2021). Personalized Distance-Learning Experience through Virtual Oral Examinations in an Undergraduate Biochemistry Course. *Journal of Chemical Education*, *98*(2), 395-399. https://doi.org/10.1021/acs.jchemed.0c01092

Summary: Describes the implementation of a virtual oral exam in an undergraduate biochemistry course at an American university. Concludes using anonymous student feedback and survey data that students valued the oral exam experience.

Research methodology: Qualitative and quantitative data collected through surveys conducted of 41 student participants (recruited through the author's biochemistry course).

Conclusions: Virtual oral exams are a positive pedagogical strategy, which students find valuable and allow them to personalize their learning, prepare for virtual interviews, and prevent cheating.

Strengths: Clearly describes how and why to implement oral exams in biology courses.

Weaknesses: Small sample size and specific context. Results were not wholly positive (e.g. 65% of students reported that the oral exam experience was valuable.) Does not make an extensive connection to academic integrity.

Utility: Useful resource for instructors seeking to implement oral exams.

Keywords: distance learning, biochemistry, oral exam

Back to Menu

Lau, P. N., Chua, Y. T., Teow, Y., & Xue, X. (2020). Implementing Alternative Assessment Strategies in Chemistry Amidst COVID-19: Tensions and Reflections. *Education Sciences*, *10*(11), 323. https://www.mdpi.com/2227-7102/10/11/323

Summary: Reflections on transitioning a freshman CHEM course online and adapting assessments for remote delivery. Focused on replacing the final exam with a concept map assignment and students' perceptions of this switch.

Methodology: Analyzed results of a survey of first-year students' (n=500) on whether concept map assignment aided learning (n=351 responses)

Utility: Presents an alternative assignment that may be more beneficial for smaller upper-level courses because of amount of work for both students and instructors. Takeaways:

(1) A concept map requires more customization and is therefore more difficult to plagiarize (easy to see when copied directly from lecture materials).

(2) Comments from students was that while useful for consolidating ideas, the map would have been more useful as a study tool rather than an assignment for grades.

(3) Instructors could see that student learning was "shallow": deeper connections between concepts were not apparent.

Key words: assessment, concept mapping

Back to Menu

Bengtsson, L. (2019). Take-Home Exams in Higher Education: A Systematic Review. *Education Sciences*, *9*. https://doi.org/10.3390/educsci9040267

Summary: A review of research on take-home exams. Major conclusion is that take home exams are effective for assessing higher-order thinking. Due to the risk of cheating, take-home exams are not recommended for testing lower-order thinking such as the recall of facts.

Research methodology: Literature review using Gough's nine-phase process which includes the identification of inclusion/exclusion criteria as well as articulated search and screening strategies and the searching of five databases (Education Database, ERC, ERIC, Scopus and Web of Science) and a search on Google Scholar. Review includes 35 sources.

Findings: There is general consensus on the two major advantages associated with take-home exams: they reduce students' anxiety and they are an excellent tool when it comes to testing students' higher-order thinking skills (although some argue that some stress may help students perform better). The most cited concern is the risk of cheating.

Utility: The review includes two tables that summarize the advantages and disadvantages of take-home exams that may be of particular interest to McGill instructors. Table 6 includes remedies for cheating during take-home exams that may also be helpful.

Notes: Two of the main controversies are (1) how take-home exams affect study habits and (2) retention. In both cases, research exists to demonstrate that take-home exams have an adverse impact, a positive impact and no observed impact. In addition, although the gain in students' higher-order thinking skills has been widely stated as one of the major advantages, more evidence is needed. An experiment that contrasts the gains in higher-order thinking skills between take-home exams and in-class exam would provide scientific evidence to support the endorsement of take-home exams.

Back to Menu