

## **Takeaways from an Online Inquiry-Based Discrete Mathematics Course**

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In March 2020, our campus was among the many around the nation that closed suddenly, making an immediate transition online. In that moment, we all collectively made the best decisions we could with the time and resources we had. At Central Connecticut State University, we had about a week to move all classes entirely online, with limited experience hosting even interactive virtual meetings. For mathematics and other symbol/diagram-heavy disciplines, Power Point slides don't cut it, so I had to quickly learn to make do using online whiteboards. Additionally, as all my courses relied heavily on group work, breakout rooms were essential for me. The initial system we were provided was clunky and awkward for both the students and instructors. Another important component of my course structure that I had to find a way to transition online is regular in-class student presentations done in real time on the whiteboard, and I could not envision suddenly placing the burden on the students of converting those presentations to electronic form. Lastly, there was the obvious challenge of preserving academic integrity on exams, which I dealt with by requiring exams to be taken during synchronous sessions with cameras on, a less-than-ideal set-up. I personally would not say that my final product that semester was an excellent pedagogical experience, but I don't know that I could have done better under the circumstances.

By the following fall semester, we'd all had not only some experience, but time to plan and make deliberate choices regarding our pedagogy. For that reason, I am focusing on the 2020-2021 academic year in this narrative, and in particular my Discrete Mathematics course (for math and CS majors), where I was using a fully inquiry-based approach, and which therefore required the most meaningful changes. In the interest of brevity, I will discuss only the most significant of those changes, which include transitioning presentations to online, redoing my assessment into a standards-based approach, and replacing exams with portfolios.

In this course, I don't lecture at all. Before the pandemic, I split each class period roughly 50/50 into student presentations and group work, where students worked through a set of guided course notes. I started each meeting by soliciting volunteers to present the next problem from the notes, and we'd go from there. Therefore, when we pivoted to online, breakout rooms would clearly be essential to maintain any semblance of the course structure. While the communication is not as easy as in person, the breakout rooms did allow me to preserve the inquiry-based learning structure, in that I did not have to switch to lecture. On the other hand,

with the potential technical difficulties, no board to present on, and no advance notice as to who would be presenting which problem on what day, live presentations in real time were not feasible. For spring of 2020, I chose the quickest substitute I could think of and simply had students post written solutions online with a comment thread instead of “presenting”. This lacked one of the most beneficial components of the student presentations, which is the discussion between the presenter and their peers. I also suspected that many students were not even reading them, but I couldn’t really fault them for that given the circumstances.

For fall 2020, I became aware that our institution had a license to GoReact, a platform where videos can be posted, and comments are clickable and timestamped. I also created a schedule of presentations in a google spreadsheet where students could “claim” each one, to be posted on GoReact on the listed date. This had the added benefit of relieving the stress that comes with worrying about content coverage, as the pacing of the course is determined entirely by the presentations.

While at first, the switch to online presentations was simply for technical and logistical reasons, as time went on, I realized there were other important benefits as well. To begin with, they were far superior to the quick fix I had thrown together at the end of the previous semester, because the time stamps enabled a chronological dialogue and the ability to easily highlight small details. Additionally, the presentations were generally of a higher quality than the in-person presentations I had previously been using, as students had time to not only prepare for them but record them several times if necessary. Also, because the comments were not all taking place in real time, the presenters could wait to respond in order to digest/process and deliver better overall responses that demonstrated that they had really reflected on their peers’ observations. When done in real time in person, the student can tend to panic and just freeze, deferring to their classmates to help them through. Finally, the sheer amount of class time I gained was invaluable. The extra time in groups really provided the necessary space for students to think through the problems on their own, an essential part of the success of an inquiry-based approach. As there are still many valuable components to in-person presentations delivered in real time, in heading back on ground this fall, I aim to split them about 50/50 online vs. in-person.

Another major change was a complete overhaul of my assessment, in particular adopting a standards-based grading system and replacing exams with portfolios. Previously, I had been using a grading system out of 10 points for each problem (with rewrites allowed), with a minimum number required to have been submitted by the end of the semester (under certain weekly constraints). My exams were also fairly standard, timed and in-class. However, I realized after the spring 2020 semester that balancing my pedagogical goals with the restrictions of being online and the burden of being in a pandemic was going to require a step back to see the big picture, avoiding focusing on minutiae. Not only would too many details be stressful for the students, it would be stressful for me as their evaluator, feeling obligated to detail every missed assignment, low grade, or suspicious solution. I wanted none of that. I sought an assessment system with freedom and breathing room, that evaluates the forest rather than the trees. And

truthfully, it seems so obvious now that this should be my approach always, not just when we are online in the middle of a pandemic! I ultimately settled on a M(astered)/P(rogressing)/N(ot yet) system of grading for each problem, which I converted to 2/1/0 in my gradebook for easier bookkeeping and final evaluation. This really allowed me to accomplish the more holistic approach to grading I'd had in mind, and at this point, I can't imagine going back.

I believe academic integrity is something we all struggled with in the online environment, and that we had to be very deliberate in working to combat unethical behavior. For myself, I realized after fall 2020 that that was not the battle I wanted to fight. In fact, I had been hoping to find a way to eliminate timed exams for a long time, as they weren't really assessing true problem-solving skills anyway, but I suppose I wasn't truly motivated to do so until teaching online during a pandemic made it easier and less stressful to change than to stick with what I knew.

I therefore decided to use portfolios for the larger assessments. The portfolios consisted of a selection of problems of the student's choice, accompanied by all scrap work, including any shared notes from group work, any rewrites done along the way, and finally a discussion of the student's learning process and learning gains. This required students to choose not the easiest problems, but the hardest, the ones where they had struggled the most, in order to have something significant to discuss. It also really helped measure if students had truly understood or just copied a solution, in that if it were the latter, there would really not be much to analyze in terms of their learning. Although grading the portfolios was much more time-intensive than grading exams, I feel the benefits were too significant to consider abandoning them. Going into this fall, I plan to keep the system of portfolios, and I am considering a choice of a portfolio or exam track for the small minority of students who really struggled to discuss their learning despite having demonstrated good understanding otherwise.

Overall, while none of us could ever say the pandemic was a blessing, there were some silver linings. I grew more as an instructor in these past 18 months than in at least the five years preceding them. The need to "trim the fat" helped me hone my pedagogy into a much more streamlined, targeted, learning-outcome-oriented approach, and I am grateful for that.