Teaching Statement

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Fall 2022

The Student

Who is mathematics *for*? Francis Su considers this question in [1], and answers it in a profound way: mathematics is for *everyone*. Mathematics is for those of every race, national origin, age, gender, sexual orientation, gender identity or expression, religion, disability, creed…it is for *everyone*, and any person, structure, system, institution, etc., that impedes the mathematical exploration of another is diminishing that person and preventing them from living their fullest life of flourishing.

In my teaching, I therefore seek to create educational environments in which every student can flourish. My deep hope for my students is that they leave my class firm in the belief that mathematics is for *them*. I aim to accomplish this in large part by making distinctive choices in pedagogy and assessment.

Pedagogy

By now it is clear from research (see [2], among many others) that authentic student engagement with mathematics is key to building deep, lasting learning. To that end, I build my courses around active, inquiry-oriented learning, which the Academy of Inquiry-Based Learning defines via four pillars:

a. deeply **engaging** students
b. providing students with opportunities to **collaborate** with their peers
c. instructor focus on **student thinking**
d. instructor focus on **equity**

Engagement and Collaboration

In my courses, student engagement and collaboration go hand-in-hand. Students spend very little time listening to me talk; at most, I am introducing some new ideas, or putting recent or imminent explorations in a larger context. My courses are driven instead by collaborative student work. The nature of this work depends on the course.

In first/second-year courses such as calculus or linear algebra, students spend time in groups working on carefully structured explorations, such as those found in the excellent calculus text, *Active Calculus*[1], or my own liberal arts mathematics text, *Explorations in Modern Math*[2]. The explorations introduce new concepts and offer opportunities for the practice and extension of ideas. For many of these students, active learning in a math class is a new experience, and they benefit from the structure provided by the explorations.

Once they reach proof-based courses, their training in more structured active learning environments begins to pay greater dividends. In these courses, my students typically work to prove the main theorems of the class

[1] https://activecalculus.org/
[2] https://emmath.org/

themselves using resources such as *Rings with Inquiry*[3], a rings-first, inquiry-oriented abstract algebra text I wrote with a colleague. Students are assigned 3-5 problems daily, and then spend the entirety of our class meeting engaging with one another's solutions. Building a classroom culture in which students are unafraid to stand up in front of their classmates to present their thinking on a problem is essential. A key is to normalize the making of mistakes early. Of course they will make mistakes! But I will, too! Mistakes are a key part of the learning process, and thus students are not harshly penalized for their mistakes on in-class work.

Assessment and Student Thinking

The third pillar of IBL is a focus on student thinking. While an in-class focus on student thinking follows naturally from an inquiry-oriented classroom through discussion, authentically *assessing* student thinking takes a bit more thought, and again, the current state of my practice varies depending on the type of class.

One way that I have assessed student thinking is through the use of alternative grading perspectives, such as specifications grading; see [3,4] for examples. The key idea underlying these forms of assessment is that students learn at different paces; thus, the opportunity to reassess or revise their work gives students an opportunity to demonstrate that they have eventually met the course learning objectives.

In courses like calculus, I identify a specific list of learning targets[4]. Each exam contains problems clearly assessing a pre-announced subset of those learning targets; if a student gets a problem assessing a particular learning target essentially completely correct, clearly explaining their thinking and showing relevant work, they earn full credit. If they don't, they get no credit, but can reassess on future quizzes or exams. If they pass the missed learning target the next time, they get full credit. What matters is what they *eventually* show me that they know. Moreover, the learning target provides focus to my assessment of their work; minor algebra or arithmetic errors can often be ignored *if they demonstrate proficiency of the given learning target*[5].

In courses such as the abstract algebra class described above, I wanted an assessment structure that honored the daily work of solving problems and presenting/discussing solutions in class. In short, if I think it's important enough to spend our precious class time that way, then my assessments should honor that. On the daily work problems, students earn some credit just for being willing to present their thinking. On the longer biweekly written homework, students are assessed at one of four levels: Exceeds expectations, Meets expectations, Revision needed, Not assessable[6]. All students have one free revision to their work based on the comments that I leave on it. And exams are a hybrid of take-home and oral: students are given a list of problems ahead of time, and then given 24 hours to solve a proper subset of those problems, write them up, and submit them. The exam consists of an office meeting in which we interrogate their thinking on each problem. Students are

[3] https://ringswithinquiry.org
[4] See, e.g., https://prof.mkjanssen.org/c1/index.html#learning-targets
[5] Of course, this is not always possible, e.g., when using the limit definition to calculate the derivative of a function. There, algebraic fluency is crucial to demonstrating proficiency of the calculus concept.
[6] See, e.g., https://rtalbert.org/specs-grading-emrf-2/ for more.

spared the stress of having to solve a problem on the spot, but must be able to clearly explain their thinking for full credit.

Equity

The final pillar of active learning is an instructor focus on equity. While the use of IBL does not guarantee an equitable class, it makes the creation of a welcome, equitable environment easier. In group work-focused courses, I am able to spend time visiting every student in every group to see how they are doing and answer their questions; class time is not just for those who are confident enough to answer or ask a question in the context of a lecture. In student presentation-oriented classes like abstract algebra, all students have equal access to the problems for presentation, and I work to make sure that presentation opportunities are distributed equitably.

Additionally, as the footnoted links above suggest, I am a proponent of using open course materials whenever possible. This ensures that all students have access to all course resources from the first day of the semester. Again, while adopting OERs does not guarantee an equitable classroom, research suggests that it can help[7]. I believe in this enough to create some of my own materials and share them broadly, an area in which I intend to continue to be active.

References

[1] F. Su, C. Jackson, Mathematics for human flourishing, Yale University Press, 2020. https://books.google.com/books?id=xq7DDwAAQBAJ.

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[3] J.B. Collins, A. Harsy, J. Hart, K.A. Haymaker, A.M. (Armstrong) Hoofnagle, M. Janssen, J.S. Kelly, Austin Tyler Mohr, J. OShaughnessy, Mastery-based testing in undergraduate mathematics courses, PRIMUS. 29 (2019) 441–460. https://doi.org/10.1080/10511970.2018.1488317.

[4] L.B. Nilson, C.J. Stanny, Specifications grading: Restoring rigor, motivating students, and saving faculty time, Stylus Publishing, 2015. https://books.google.com/books?id=UrCpCwAAQBAJ.

[7] https://www.cccoer.org/2018/10/09/on-equity-diversity-inclusion-and-open-education/