My primary goal as an educator is to help students discover the joy of mathematical thinking, by experiencing it for themselves. Too often, instructors employ a waterfall approach to teaching mathematics, pouring facts and theorems directly onto students that they must scramble to memorize and imitate on assessments. A more authentic mathematical experience involves open exploration and inquiry; however, without proper scaffolding, students can find themselves aimless in this pursuit.

As a PhD in mathematics, most of my abilities were learned “on the job”, imitating techniques I’d observed from instructors I personally enjoyed. Of course, as a future professional mathematician, my needs as a student were different from many of my own students’ needs. Thankfully, training from my current institution’s Innovations in Learning Center, and in particular our “TeamUSA” Team Based Learning (TBL) QEP, helped me to develop pedagogical techniques appropriate to serve all my students.

In particular, the majority of my time spent teaching at my current institution has focused on two major innovations: a variation of TBL specific to mathematics now known as Team-Based Inquiry Learning (TBIL), and tools and techniques related to outcomes-based grading (OBG). I co-developed the TBIL model with my colleague Drew Lewis, with the support from the ILC and TeamUSA. In particular, TBIL blends the careful scaffolding of Team-Based Learning (necessary to engage students at all levels) with the exploration of Inquiry-Based Learning (IBL) (necessary to engage students with authentic mathematical experiences).

IBL is a widely-adopted model of mathematics education, backed by research that indicates improvements over lecture-based instruction, particularly for women [0]. Team-Based Learning also is well-studied (see [1] for a brief bibliography), but its implementation in mathematics was minimal when I was first trained in 2016. To that end, I worked with Lewis and another colleague to publish [2] documenting our model of TBIL for undergraduate mathematics. That work has since been recognized by our NSF grant [3] implementing TBIL at several institutions across the country, witnessing its viability.

My personal contributions to this work rely on my experience as a game and puzzle designer to know how to create carefully scaffolded (and enjoyable!) challenges for both players and students. This experience includes authoring two published puzzle books for general audiences, and serving as director of the national Mathematical Puzzle Programs organization. I also have utilized my prior experience as a software engineer to develop appropriate cyberinfrastructure for the implementation of TBIL. By leveraging free and open-source software along with Learning Management Systems, we are able to put TBIL materials directly in the hands of instructors and students without unnecessary paywalls or other logistical barriers to adoption. My work creating and utilizing Open Educational Resources has also been recognized by an NSF grant [6] supporting software ecosystems that support the creation of accessible OER.

The dual of instruction is assessment, and I am also very active in the development and implementation of evidence-based practices [4] in measuring student learning. My implementation of OBG associates each exercise on an assessment with a particular learning outcome of the course. Rather than weighting and averaging various numerical scores together to approximate a rough measurement of student learning, I generally track progress on individual learning outcomes as Meeting Expectations, Showing Progress, or Lacking Evidence. Students that do not yet meet expectations are given opportunities to learn from their mistakes and reassess understanding of that topic, providing a safe environment to productively struggle, receive feedback, and improve their work (which ultimately is more authentic to the experience of doing mathematics in academia and industry).

The logistical considerations necessary to allow students to attempt and reattempt demonstration of learning of various learning outcomes throughout the semester are often overstated, but still not trivial. Technology again comes to the rescue; by appropriately using the Canvas LMS's Outcomes, Rubrics, Speedgrader, and Learning Mastery Gradebook features, student progress for each learning outcome is easily marked and communicated to students. To generate randomized on-demand assessments for students, I developed the free and open-source CheckIt Platform [4], which is now used by instructors at several universities to author and generate high-quality outcome-specific exercises for use in LMS and print.

Ultimately, the strength of my teaching practice is witnessed both by the overall positive ratings and comments I have received in my student perceptions of instruction surveys, and the high quality of work my students have produced in part thanks to my utilization of TBIL and OBG practices in my classroom.

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