Building and Sustaining Community by Centering Affective Learning Goals

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"… I am finally proud to call myself a mathematician. It is more than just proofs and numbers; being a mathematician means being resilient, resourceful, and tenacious when faced with a problem".

-Parker, Final Essay

Introduction

Without doubt, the Spring 2020 term was exceptional, and the COVID-19 crisis impacted all aspects of our lives. In what follows, we describe our decision to value and maintain *affective learning goals* (ALGs) through COVID-19 in an upper-division undergraduate mathematics course at a comprehensive university in the Pacific Northwest. We hypothesize that having affective learning goals gave us a way to focus our course through crisis, maintain class community, and continue to promote students' mathematical growth.

We usually think of mathematical assessment in terms of homework, exams, and other summative metrics for judging student content knowledge. However, a focus on student self-assessment of ALGs (see Table 1) allows students to express changes to their identity as mathematicians, honor their humanity, and promote community. As seen in the opening quote, we have evidence from students' final essays to show how ALGs were met and valued by students. Furthermore, we show that engaging in affective assessment need not negatively impact cognitive learning goals.

The first author of this paper was a researcher observer for the term and the second author was the instructor. Our focus on ALGs was made easier since this was a capstone course, and the instructor's socio-normative background as a cis-white female with tenure allowed her to make course changes without fear of repercussion. We see this paper as a narrative of our term and experience in promoting ALGs through the COVID-19 crisis.

Final Student Essays

Table 1 gives examples of how students met the class ALGs (listed in the syllabus) through self-assessment in their final essays. These quotes are representative of the overall student experience in class and we include them as anecdotal evidence to support our belief that maintaining a focus on ALGs through the COVID-19 crisis was beneficial to students. The remainder of this paper illustrates our journey and intentions in focusing on ALGs.

Affective Learning Goal	Student Quote
1. Value the challenges of doing mathematics independently and the pride of success in mathematics.	"As chaotic as this semester and course have been, it has been through Real Analysis that I have begun to feel like a real mathematician." -Bryce
2. Gain confidence in their ability to solve problems and write proofs.	"I started off being terrified of proofs and not wanting to ever do them to eventually loving them and generally getting excited to prove theorems and other problems. Real Analysis taught me to love proofs and taught me how to challenge myself when it came to thinking about math". -Joshua
3. Gain confidence in their ability to present solutions and proofs in front of peers and faculty.	"However, as class went on, through discussions it became clear that everyone was struggling, and I was more willing to set aside my own ego and insecurities and ask questions, I also became less afraid to present and fail. Presenting still made me nervous but I was less afraid to do it." -Hayden
4. Help others by creating and maintaining a supportive and inclusive learning environment, where differences are respected and valued deeply.	"During the pandemic the one class that makes online worth it, is by far this class… We really helped each other, and I appreciate them [the students] so much. This class shows what it means to be a class… this class was about not only yourself understanding the problem but making sure the person next to you also understood it." -Jordan

Table 1. Affective Learning Goals and Student Quotes

Beginning of the Term

Real Analysis is a capstone course for mathematics majors, where students demonstrate mastery of proof-writing and critiquing, abstract thought, and synthesis of definitions. The course has been taught at the university using Inquiry Based Learning (IBL) (Ernst, Hodge, and Yoshinobu 2017) since 2006. The student-centered and student-directed nature of IBL meant that students spent class time presenting solutions to problems and proofs of theorems to their classmates, who then performed peer review, debated details, and suggested alternative solutions. Notably, the definitions and theorems were scaffolded so that students had all the material they needed to write a proof from what had been previously established. Outside of class, students had a standing assignment to "do something", such as work out a proof of the next theorem or interpret a definition. There was no textbook nor outside resources for the students other than each other and the instructor's office hours.

The focus on community and centering of ALGs started on the first day of class. Rather than reading the syllabus and listing learning expectations, classroom norms were co-created by students using a Question Formulation Technique (Rothstein and Santana 2012), wherein students proposed questions that addressed the prompt "We understand calculus well." Examples of questions that arose are "Who is *we*?" and "What counts as *well*?" Students collaborated, combined ideas, listened to and amplified others' voices, began to hone their questioning skills, and built confidence in their mathematical voice. Students also participated in several non-content activities such as writing a *This I Believe* essay (Salomone 2014), which linked personal foundational beliefs to mathematical axioms. Thus, the instructor made it clear that affective values would be honored, discussed, and supported in the classroom.

Remote Transition

The pivot to emergency remote instruction occurred nine weeks into a fourteen-week term. The instructor made instructional decisions that allowed for a continuation of student-centered pedagogy and community-building. Her concern, of course, was that students working in isolation would struggle to collaborate, and that the strong community of learners she and the students had fostered for nine weeks would be lost.

Student presenters posted their proofs in online class forums before the optional synchronous meeting. This provided opportunities for classmates to leave comments and converse before class began. During the meetings, which had almost full attendance every period, students presented their solutions on-screen, and discussion continued as it would in person. Students submitted electronic copies of their homework, rather than their usual paper copies. The final exam was already planned as a take-home exam and was unaffected by moving the class online.

Shifting Assessment

Anticipating a lack of students' cognitive and emotional bandwidth, the instructor cancelled one major content assignment, the course notebook, which was meant to contain solutions to all the problems completed by the students during the term. The forum pages became a record of the work completed, and the reflection on that work was moved to a much shorter course portfolio. The instructor chose to honor the difficulties of social isolation, change in instructional modality, and disappointment surrounding expected cultural events such as graduation by addressing ALGs more explicitly, and asking students to self-assess their learning in both cognitive and affective realms in the course portfolio. She also facilitated regular check-ins, both privately with individuals and during the class meetings. Students connected with each other using assignments such as the *This I Believe* essays, which they read aloud during class meetings. Content assessment took the form of grading presentations, noting asynchronous participation via forum comments, and standard grading of the take-home exam.

While the shift to caring for student mental health and addressing concerns unrelated to course content took class time, all the cognitive learning objectives were met or exceeded by all

students. However, cognitive objectives were not tied to specific content, but rather to mathematical practice skills, such as "The successful student will demonstrate increased understanding of logical structure by presenting proofs (both orally and written) and by critiquing their own proofs and those of their classmates." The decoupling of cognitive learning objectives from specific content allowed the instructor to revise the topics covered, to support the students in diving more deeply into a smaller set of ideas, and to do so without sacrifice to overall skill-building. Students completed class with a deep understanding of field axioms and their impact on arithmetic, sequences, and continuity, but did not prove facts about differentiation, a topic that would be included in a typical Real Analysis course. However, as a terminal course for most students, the trade-off of promoting student welfare over course content was not detrimental to their progress in the degree, and, in fact, allowed many of them to see the ways in which they had grown as mathematicians *in light of* the challenges of a global pandemic.

Conclusion

In this paper we have shared our narrative and reasons for focusing on ALGs above content or cognitive goals during the COVID-19 crisis. In true IBL nature, we chose to omit a conclusion in favor of leaving the reader with three final questions:

1. What ALGs do you have in your classroom, how do you show students you value them, and how do you assess them?

2. How do you and your students balance content, cognitive, and affective goals in the classroom?

3. What do you gain and lose by dedicating time to ALGs in the classroom?

References

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