

Creating a Math Classroom Environment that Promotes Independent Learning and Perseverance

Our cohort consists of three members, Chris Cary, Jessica Hoppe and Molly Coulter. Chris and Jessica are community college instructors at Spokane Falls Community College and Molly works at Dishman Hills High School, an alternative school in the West Valley School District of Spokane.

Spokane Falls Community College is primarily transfer institution with 75% of students planning to attend at 4-year institution after completing their coursework at the community college. All courses are on an 11-week quarter system with 58% of students attending school fulltime. SFCC has 67% of its demographic at or below 25 years of age. At SFCC data was collected in developmental Algebra I, II and III courses. In short these titles correspond to the study of linear relationships, the study of quadratic relationships and the study of other functions. An average size for one of these courses is 25 students.

Dishman Hills High School is on a 16-week semester system. The students at DHHS have unique challenges in their education. Many have had life traumas that have kept them from attending school regularly. They are parents, they come from families with drug/alcohol issues, they live in poverty, and school has not been a priority. Consequently, they arrive at high school with little understanding and appreciation of math. Data at DHHS was collected in Washington State Bridge to College courses.

After getting to know one another's teaching contexts a little better the three of us decided that we wanted to focus our energy on helping students realize their potential as learners of mathematics, and to help them believe that they are capable of coming up with their own mathematical ideas. We noted that at each of our institutions it seems that students view the teacher as the "havers" of knowledge and themselves as the "have nots." We wanted students to know they are capable of solving difficult problems without our help. We believe that we can address students' struggles transitioning from high school to different levels of higher education by targeting this issue.

Our objective was to help students transition from high school to community college or from high school to university seamlessly, and to help smooth the transition for students going from the community colleges to universities by working to create a classroom culture that fosters independent learning and perseverance.

Specifically, we wanted our students to:

- welcome challenges and work through them together or independently
- take ownership of their own learning
- view the teacher as a facilitator not an answer book
- believe that they are capable of solving any problem if they stick with it and

persevere

We have confidence that these traits will carry over into other situations in school and life to make our students stronger. Much of what we were aiming towards aligns closely to the Common Core State Standards for Mathematical Practice as our mission was centered around creating an environment where students were making sense of problems and persevering in solving them (MP1), however to achieve this goal much of what we did in the classroom aligned with the other standards for mathematical practice as well. The rubric we developed for our rubric tasks was designed in such a way that it should target most of the SMP with each task.

As with any inquiry project, the first stage in our process was research. We researched possible classroom interventions that would help us create a student-centered environment that would aid in creating a culture of perseverance. Starting with some articles from one of our project leads, we read in detail about supporting deep conceptual learning. From there we began researching more specifically how to set up and maintain classroom norms that support independent learning and specific activities that promote deep thought in algebra.

We spent several months reading and reflecting on research articles and came away with a few intervention tools and measurement instruments to apply to our classes starting in Winter of 2016. We also found some tasks that we thought were written with a low floor high ceiling to use as our rubric tasks; our website includes examples of these tasks as well as the rubric we used to score them.

Some of the most notable work we called on was from Angela Duckworth, Jo Boaler, Carol Dweck. Additional articles that informed our research included:

- “The Effects of Classroom Mathematics Teaching on Students Learning” - Hiebert and Grouws
- “Levels of Cognitive Demand”—Derived from the work of Doyle on academic tasks (1988) and Resnick on high-level-thinking skills (1987), the Professional Standards for Teaching Mathematics (NCTM 1991), and the examination and categorization of hundreds of tasks used in the QUASAR classrooms (Stein, Grover, and Henningsen 1996; Stein, Lane and Silver 1996).
- “Teaching for Understanding Teaching”— Dvora Peretz. For the Learning of Mathematics, Vol. 26, No. 3 (Nov., 2006), pp. 24-29, 38
- “Deep, surface and strategic approaches to learning”— Jackie Lubin
- “Supporting Deep Conceptual Learning”— Peter Rillera and Helen Padgett

At the start of each quarter at the community college, or semester at the high school, all three instructors gave a 12-Item Grit Survey developed by Angela Duckworth, as well as a Math Perceptions Survey. Our goal was to measure the impact of our cultural interventions. After some question as to the validity of the Math Perceptions Survey we decided to include a new survey in Fall 2016 that we are calling the Student Self Knowledge Survey. The goal is that this new survey will hopefully replace the Math

Perceptions Survey. The initial plan was to give these surveys at the start and end of each term to measure changes, however after collecting our first set of data we decided to add in a mid-term surveys as well.

Within the first week of class we all spent time establishing the desired classroom environment. This was the first part of our intervention. Setting up this environment was achieved in different ways but with lots of dialog between students. We all also decided to have our students within the first week of class reflect on an article about the Levels of Cognitive Demand, namely Memorization, Procedures without Connections, Procedures with Connections, and Doing Mathematics, within.

To help us gather some anecdotal evidence we all agreed to give three tasks per quarter that we would assess on a common rubric focused more on process and communication than on answers. These tasks required a higher level of perseverance than most other classroom tasks and thus gave us a way to formatively assess whether our students were “sticking with it” more as the course progressed. These tasks were different for each of us, but the rubric was consistent.

After each round of interventions (we have now completed three iterations and are nearing the end of our fourth) we met to reflect on our data results, refine our interventions and measuring tools, and start prepare for the next iteration.

With us each having different classrooms and different instructional styles there were some differences in our interventions as well. Jessica started each quarter of her Algebra I courses (Winter 16, Spring 16) with the “Week of Inspirational Math” activities and videos from Jo Boaler’s youcubed.org site. When she taught Algebra III (Fall 16), she chose to only include the videos from the week of inspirational math without the supplemental activities. Also, beginning in Fall 16 she started to add regular (2-3 times per week) Number Talks in her classes from Ruth Parker and Cathy Humphrey’s “Making Number Talks Matter.” This quarter in Algebra II, she decided to use the videos again but also required her students to enroll in an online six-lesson course, to supplement these first week lessons, which were spread out over the course of the quarter. Chris has also added Number Talks and the Stanford Mathematical Mindset class as required activities in Fall 16. Molly started each iteration with team building activities as well as activities designed to help students determine what behaviors assisted positive group work, and what behaviors hindered positive group interactions. Each unit of the Bridge to College course contains an additional lesson that refocuses students on these positive group norms and community building activities. Additionally, beginning in Fall 16, students were introduced to Number Talks weekly in class. All three instructors worked hard to provide in class opportunities for the students to talk about math.

Winter 16 we assessed the results of our interventions by collecting students’ responses to the Grit survey and Math Perception survey. The survey data was collected once at the beginning of the term and once at the end of the term. We also collected anecdotal

evidence from instructor observations in class and when assessing the rubric tasks throughout the quarter.

When we met at the end of the first iteration we had some positive anecdotal evidence based on observations of student behavior, attitudes, performance on items, and examples of student work, but were unsure of where to begin in analyzing the survey data. The group felt that the cultural interventions seemed to be successful in moving towards the types of changes in students we were hoping to see. We did not expect the Grit Scale Survey results to change much because we hypothesized that changes to Grit would take longer than one quarter. Our goal is, when possible, to test students over multiple quarters with this tool. As for the Perceptions Survey, we thought the higher the level of class the more consistent the scores might be because they may come in with more realistic expectations but expected to see increases as a whole.

In order to analyze the survey data more effectively our cohort began to collaborate with two institutional researchers from the participating community college. Initial Grit data collected appeared consistent with our predictions that affecting Grit would take more than one quarter; the data was not significantly different pre/post. Since the Math Perceptions Survey was 39 questions, factor analysis categorized the questionnaire into three categories, namely:

- Like: Attitude towards Math
- Relevance: Feelings about Relevancy
- Try: Belief that Hard work is Rewarding and Rewarded

Initial results of the Math Perception survey were discouraging in that it appeared students' measures had declined throughout the term. These results contradicted our observations. For example, Jessica's initial impression was that the cultural intervention was successful. "Students were actively engaging in problem solving tasks and working together on difficult problems. The classroom was a space for inquiry." Chris noted, "Students seemed to like doing the grit scale and math perception survey.... The classroom is currently a very positive space and for many students a safe place to express ideas," but also mentioned that there were still some students not feeling as safe to express ideas. Molly commented on students' self-assessments noting "students weren't very honest in their self-assessment on their Grit Scale. Not sure if this is because they are self-unaware or if they are trying to tell me what they think I want to hear."

Working in conjunction with the institutional researchers, our cohort reflected on the differences in our observations and the results. We began to wonder if students' perceptions and attitudes might decline after the beginning of the term, in response to an adjustment to the expectations of the content and the course, and then rebound later in the term, albeit not so much to exceed the initial measurement. As a result of the collaboration, Chris and Jessica adjusted their plans for the second iteration in Spring 16 and implemented the survey tools a third time, in the middle of the term, to

determine if such a “dip” was occurring. Molly was unable to make changes at this point because she is on a semester system.

Other than implementing the surveys three times over the quarter, Chris and Jessica still continued with the same intervention strategies in quarter two. The data from the Grit surveys was consistent with the first set of data collected but the results of the perceptions survey this time around were less clear. The inconclusiveness of the results led to many questions from both the cohort members and the researchers.

Some of our questions included:

- Are the assessment tools measuring what is intended? For example, actual perseverance vs. students’ feelings about needing to persevere.
- What is the history of the assessment tools? How have they been used and are they reliable?
- Are there other factors we should be considering such as attendance, academic history, or other risk factors?
- Are there other questions we should be asking that might be more foundational?
- What are the effects, if any, of giving a survey right after a rubric task or test as opposed to before a rubric task or test?

Our cohort just finished the process of analyzing data from our third iteration (Molly’s second) compiled from Fall 2016. Because our perceptions data was rather inconclusive, we decided to seek help from some of the project leaders and found a new tool for measuring attitudes. At the start of fall quarter/semester we gave the new “Self-Knowledge” survey in conjunction with the old “Math Perceptions” survey so that we could do a comparison of the two attitude studies; we also continued giving the Grit survey. Moving forward we will only ask students to complete the Grit and Self-Knowledge survey. In addition, we decided to look more closely at student demographic data and how factors such as ethnicity, number of previous math classes taken, level of current class, age, grade average, grade in previous math class, gender, attendance and grade earned in the course impacted the survey results. We still used rubric tasks but fall quarter Jessica added in a choice component to the tasks and asked students to write a paragraph explaining why they chose the task they did.

Unfortunately the message was just as muddled from this term and we weren’t able to note any significant effect to any of the student’s attitude or belief measures on their final grade.

One of the challenges we have at trying to look at the big picture across terms is that since we changed our measuring device we do not have many measures that we have used every term. We have the Pre-perception, the Pre-Grit, the count of students’ prior developmental math and average grade on those, and their demographic data. The only statistically significant measures we found were that being male has 0.009 sig. value in

relation to grade and that average grade prior has a correlation of .000 sig value in relation to grade earned. Based on what we have collected it appears that grade in the previous math classes taken was the highest predictor of course success.

Though our data has not been conclusive, we each still feel like the interventions we are making are impacting our classroom culture in positive ways; therefore, we have decided to enter into another term of research. Winter 2017 we continued using the Grit and Self-Knowledge Surveys, the rubric tasks and, at the community college both instructors decided that they wanted to increase emphasis on mindset throughout the quarter by adding in a free online class for students through youcubed.org.

In terms of data collection, we also are considering trying to find students after the course is over then to ask them to provide a written reflection at the beginning of the next quarter to see if perceptions change once the stress of final grades is gone.

Additional areas we are interested in investigating are what practices are getting in the way of achieving our goals. Areas to consider are:

- Online homework that has “help me solve this” and is primarily procedural.
- Questions that are not open enough to develop rich mathematical ideas; ones that send the message that the students have to follow the steps and repeat someone else's way of thinking.
- “Rescuing” students, teaching students that they always need to be rescued, that they cannot do it themselves.