SNAPSHOTS OF EQUITABLE TEACHING IN A HIGHLY DIVERSE CLASSROOM

Two instructional principles—being open to students' input and building on misconceptions—can open the door for mathematics learning in community college.

RUTH N. URBINA-LILBACK

I clearly remember that Tuesday morning at 8:00 a.m. It was the first day of my Elementary Algebra class at the community college. I looked around the room with excitement, eager to greet my new students. I was met with utter silence and apprehension. A palpable sense of anxiety permeated the room. Out of twenty-four students, twenty-one were recent high school graduates in their very first college classroom. The other three students were taking the course for the second time. Multiple thoughts flooded my head. Among them were the disquieting statistics that apply to this developmental math class, typical of so many others: 59 percent of entering community college students are referred to a class in a developmental math sequence. Of those, only about a third actually completes the sequence. And of this third, only about half actually go on to complete the gatekeeper collegiate math course.

The statistics about community college developmental math level and completion rates (which are mentioned in the recollection above, and which were reported by Bailey, Jeong, and Cho [2010] and displayed in **figure 1**), can seem disheartening, especially for those of us who work with these students day-to-day and know their life stories. When it comes to teaching my students, I choose not to focus on the statistics. Instead, I pay attention to their varied career goals and the life experiences that characterize who they are. This diversity means a world of unexplored possibilities for me, their math teacher who wants to provide them with a strong quantitative background, regardless of their eventual college choice.

The real hurdles, however, are how to provide them with a solid mathematics foundation while helping them learn how to conquer their unique challenges and the many years of imprinted preconceptions about what it means for them to learn math. Perhaps the most pressing element affecting this real-life scenario is time: All of these challenges must be overcome in one semester—twenty-eight class sessions, to be exact.

WHY COMMUNITY COLLEGE?

Community colleges are an attractive higher education alternative chosen by approximately 36 percent of U.S. college-bound high school graduates (U.S. Department of Education, National Center for Education Statistics 2014). Community colleges provide educational choices that can support our country's skilled labor force through associate degrees and certificates. They also provide educational advancement to universities through transfer options (Mesa, Wladis, and Watkins 2014). Compared to four-year institutions, community colleges have a higher level of diversity in their classrooms, with larger proportions of

PLUME CREATIVE/GETTY IMAGES

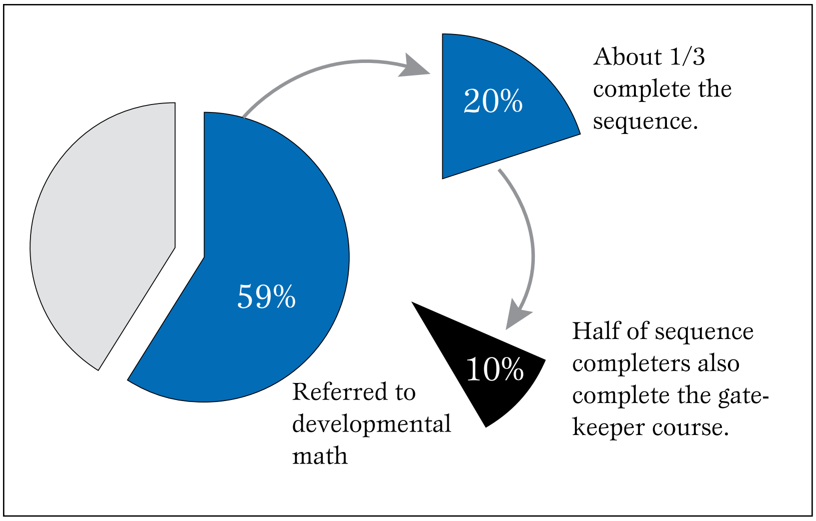


Fig. 1 These developmental math level placement and completion rates for students in community colleges are based on Achieving the Dream data reported by Bailey, Jeong, and Cho 2010.

students who are nonwhite, are the first generation of their family to attend college, are of low socioeconomic status, or lacked upper-level math courses in high school (Mesa et al. 2014). As such, community colleges are a potential source for educational access and social mobility for many historically underserved populations. Their rich classroom diversity is a perfect backdrop for exploring equitable mathematics teaching practices. Thus, issues of math education at a community college may provide particularly important insights that are relevant to both secondary and collegiate math education programs.

THE IMPORTANCE OF PERSISTENCE

According to a study of historically underrepresented college students, the second-best predictor of college readiness, after socioeconomic status, is time spent studying (Strayhorn 2014). Despite acknowledging the importance of studying, these students often lack the proper study skills or face life responsibilities that reduce their ability to dedicate time to their education. For students in developmental math classes, the task of spending time studying can be even more daunting. Having consistently struggled with math, most students in these classes have developed fixed beliefs about their abilities. They expect failure instead of improvement. Low persistence is commonly observed and is especially evident in students' course progressions. According to Bailey and colleagues (2010), student failure is not the leading reason for the low completion of developmental course sequences—in fact, more students choose not to enroll in the first or subsequent courses.

In order to overcome the challenges related to persistence, students need to have learning experiences in which they recognize that learning gains depend on engagement, effort, and dedication to their studies. Students must therefore adopt a growth mindset (Dweck 2007) to realize that effort and productive struggle lead to learning.

The mathematics classroom is a perfect place to develop this mindset, especially when our teaching practices are grounded in the understanding that our students can indeed succeed. This understanding must permeate our instructional interactions, down to the smallest of nuances, defining a learning experience that develops buy-in and an appreciation for everyone's different reasoning approaches. Although our students and their needs change every year, we must consistently use equitable practices to frame our overall intentions and behaviors.

OUR PRACTICES MAKE A DIFFERENCE

This article looks at my own efforts to develop and implement successful instructional experiences within an elementary algebra classroom at a community college, a common entry-point course with content similar to what is taught in high school algebra 1. While contexts and developmental stages between school levels may differ, increasing mathematical access and developing lifelong mathematics learners is a central objective for all mathematics teachers.

The two basic principles presented here, based on instructional experiences and a review of relevant literature, may be used to increase mathematical access effectively.

Principle 1: Design flexible lessons that are open to student input. Balance time to establish relationships with and among students.

The importance of relational components in the classroom cannot be overstated. Teachers teach individuals. Students have different cultures, life experiences, and formed identities. These differences need to inform our instructional approaches, but in order to do so we must find creative ways to get to know our students. Civil (2014), for example, advocated for the use of students' inside-of-school and outside-of-school knowledge. Thus, she proposed a holistic approach to mathematics education. Similarly, Gutiérrez (2002) found that using students' life experiences was a successful approach for teaching high school mathematics to marginalized students. Knowledge of the student is extended here to the identity that the student brings in to the classroom as well as the identity and culture co-constructed from classroom interactions. This principle is primarily based on social construction as applied in mathematics education (Bishop 1985), and without it, the second principle could not be implemented. A flexible lesson can change the

scope of an activity when a major misconception is encountered, and it uses students' contributions and overall knowledge base (mathematical and nonmathematical) to induce learning.

Principle 2: Build on misconceptions and errors, which can be a major source of learning.

Teachers must proactively seek to understand the extent to which students have grasped a concept, because it helps them target their instruction to particular learning needs. Researchers (e.g., Simon et al. 2004) have built on Piaget's learning theory to explicate the process of knowledge construction where new schema build on existing schema, resulting in more advanced mathematical learning. Taking this notion a step further, this principle suggests that a misconception can be rectified while in the same lesson demonstrating its conceptual relationship to earlier and newer topics. There is great value in fundamentally understanding how mathematical concepts are interconnected. Concepts build on one another within a lesson and within and across courses. Ball, Thames, and Phelps (2008) termed this type of mathematical teaching knowledge *horizon* content knowledge. Proportional reasoning, for example, is fundamental to understanding slope, which in turn has monumental implications in the study of trigonometry and calculus.

THREE SNAPSHOTS

The examples that follow—"snapshots" taken from my teaching journal—demonstrate the application of these principles and took place during the instruction of two fundamental topics in algebra: expressions and applications of linear functions. Readers are invited to enter our classroom through these snapshots.

Snapshot 1: Numerical Expressions

This snapshot illustrates the use of a flexible lesson constructed from students' base knowledge on the first day of class. After I asked what they remembered about the order of operations, students answered nearly in unison, "PEMDAS—Please Excuse My Dear Aunt Sally." I told them that this acronym, well known to them, was completely new to me because I had attended school in Puerto Rico. When I first heard it, I was intrigued by who this Sally was, and furthermore I wondered, "What am I excusing her for?" I also told them that students are a huge source of learning for me. A student once shared with me another mnemonic for the acronym: People Eat Mickey D's After School. I told my students that as a working mom, with little time to cook, this version might be closer to my reality.

Intending to co-construct our lesson, I invited students to provide the numbers to build a numerical expression that we would simplify using the order of operations. I gave them time to work out the problem, but I did not offer help. I wanted them to engage in productive struggle and question their own decisions. Instead of asking for someone to volunteer an answer, I asked for all answers that the students had obtained. I then asked for volunteers to describe their reasoning and how they made their procedural choices. Process is more important than the answer. They paid close attention to my reactions, testing to see whether I gave away any indication of the correct answer.

I continued to ask for as much input as possible so that the class as a whole started to focus on everyone's processes. Some explanations led other students to reconsider their decision making. Seeing all their original answers also helped me gauge the particular areas where they needed help. It typically takes time to develop a classroom norm that focuses on shared understanding, especially because students often use the "correct" answer to make a personal determination about whether they understand the topic or not. Many times, students understand the topic better than they think. Focusing on the process allows them to rectify misconceptions while developing self-efficacy and perseverance.

With thirty seconds remaining in class, we had already gone through five transformations of one expression, leaving us with this expression: $2 + 3(10)$. They responded in chorus: "50!" Expecting the answer 32, I looked at the board and then I looked at them. They were standing with their belongings in hand. I did not want them to leave with an incorrect approach in mind. I asked them to say aloud the operations that remained. This provoked them to reconsider their approach. I told them that with two potential answers—32 and 50—this problem clearly promised an opportunity for learning next class.

THE LESSON WAS FLEXIBLE BECAUSE IT WAS DIRECTLY INFORMED BY THE STUDENTS' PARTICULAR NEEDS.

I got here early to meet my advisees and spent 20 minutes per student.

$$y = 3x$$

Here, x is the number of hours and 3 is the rate of students per hour and y is the number of students.

Professor Johnson met advisees, also spending 20 minutes with each. She had already met 5.

$$y = 3x + 5$$

Both variables have the same meaning as in $y = 3x$. The rate of change is the same. How does the 5 change our scenario?

"I got here at 8 a.m., thinking that I will beat Professor Johnson. By the time I got here, she had already seen 5 students! After 1 hour, I had only met 3 students, while Professor Johnson had met 8. Will I ever catch up?"

Fig. 2 Equations model a current situation familiar to students.

Number of Advisees Met by the Teachers Each Hour

"She is off by just one student, ladies and gentlemen… Will she finally do this?"

Hours (x)	$y_{\text{Prof. Lilback}}$ Number of Students	$y_{\text{Prof. Johnson}}$ Number of Students
1	4	8
2	8	11
3	12	14
4	16	17
5	20	20
6	24	23
7	28	26
	$y = 4x$	$y = 3x + 5$

"Despite the faster rate, Professor Lilback is struggling to keep up with Professor Johnson. Should we get her coffee?"

"Unbelievable! Professor Lilback has caught up to Professor Johnson!"

Fig. 3 Students offered these "sportscast" descriptions to interpret the table of values.

Based on the exercise that concluded our lesson from day 1 and on my knowledge of the students (many of them worked in retail), I designed an activity based on calculating sums of money from different combinations of coins. In the next class session, we calculated the sum from two pennies and three dimes, and I reminded them about our calculations from the previous lesson. Although the order of operations was developed to provide a convention for consistent calculations, students were able to grasp the meaning of multiplying before adding in the context of adding like quantities with the same units. Each of the terms 2 and 3(10) now represented a value measure in cents. Students first needed to calculate how many cents they had from each type of coin before adding all the cents. Together we came up with the prompt "So what are we adding?" and we applied it later to explore the meaning of algebraic expressions in multiple contexts. For example, the cost of two lattes and three donuts was expressed as $2L + 3D$. The answer to the prompt "So what are we adding?" was "We are adding dollars": $2L$ and $3D$ represented the dollars spent on lattes and donuts, respectively.

Reframing Snapshot 1

Sharing my personal experiences was a way to welcome everyone's individuality into the classroom and help build relationships with students. The acronym for the order of operations, read as two different mnemonics, reinforced the understanding that we all have different experiences outside the classroom and we come together to learn. The money example was a purposeful choice because it made connections with students' jobs. The lesson was flexible because it was directly informed by the students' particular needs. Activities of this kind help students know that they have an important place in the learning experience and that our teaching is responsive to their contributions.

Snapshot 2: The Math Buffet

We cannot develop a growth mindset for our students, but we can certainly create experiences that encourage its development. When students have a chance to assess themselves and use what they learned for their own improvement, such reflection can foster a growth mindset. In this snapshot, students were given a diagnostic quiz online to complete at home in preparation for an upcoming test. On the day before the test, I facilitated a "Math Buffet." I placed markers at the whiteboard and asked students to write problems from the quiz with which they needed help. I also encouraged students to go online in class to research any questions with which they wanted help. The response was slow at first, but soon the board was full of problems in different handwritings and colors. We then arranged the problems by topic to help organize our discussions. The day after the test, I asked if there were any questions before we started a new lesson. Although I had not intended to run a "buffet" that day, two questions in green marker appeared on the board.

Reframing Snapshot 2

This open forum allowed students to share questions regardless of their ability level. Students

recognized that they are part of a community of learners where questions and practice make a difference. While it is imperative that we talk about preparation outside the classroom, tying that preparation to a "now I get it" moment will have more of an effect.

Snapshot 3: Systems of Linear Functions

This snapshot illustrates the application of the second principle: using misconceptions to develop fundamental understanding. After we had explored graphs of linear functions, I thought that students would understand the meaning of the solution to a system of linear functions. For some reason, students kept treating parallel lines and "no solution" as if they were cases to memorize. I realized they were using procedures without conceptual understanding. Their misconception called for a context they could relate to. Because it was advising month at the college, I created a scenario based on my attempts to see as many advisees as possible in comparison to my (fictitious) colleague, Professor Johnson. I asked the students to come up with an equation as well as a table of values based on information from my descriptions. Using the resulting ordered pairs, students took turns making up stories and reporting on them, like sportscasters—as if seeing advisees was a competitive event between the two professors. **Figure 2** shows the equations for this scenario.

This scenario contextualized a set of parallel lines. Students recognized that we were working at the same rate (same slope) and that we would never find a time of the day where both of us would have the same outcome. Suddenly, the form of the equation took on meaning for them. As students read each set of ordered pairs, I asked them to come to the board to graph the point. We saw the progress numerically from the table of values, as well as graphically.

The sportscast describing this competition became more engaging when I asked the class if there might be a way that I could catch up. They suggested that I increase my rate. **Figure 3** shows the students' comments.

This same scenario was revisited to solve the systems algebraically. Students were able to explore when the system does not have a solution (as in the first scenario) and when it does (as in the second scenario). We used both algebraic methods, substitution and elimination, so they could confirm the same results regardless of the method used.

Reframing Snapshot 3

Capitalizing on a misconception, this lesson helped students understand the fundamental relationships among earlier and later topics. The playful approach of storytelling reflects students' remarkable engagement level and buy-in. This type of exchange does not develop overnight. Every teaching decision has a pivotal role in building relationships and ownership. The advising scenario served an additional purpose. It aligned our persistence efforts in the classroom with those at the college level. Collaborating with advisers strengthens student support.

PLUME CREATIVE/GETTY IMAGES

STUDENT FEEDBACK SHOWS THE IMPACT THAT THESE PRINCIPLES HAVE HAD ON THEM.

FOCUS ON FEEDBACK AND SUCCESS

Our first two snapshots showcased the co-construction of lessons using students' foundational

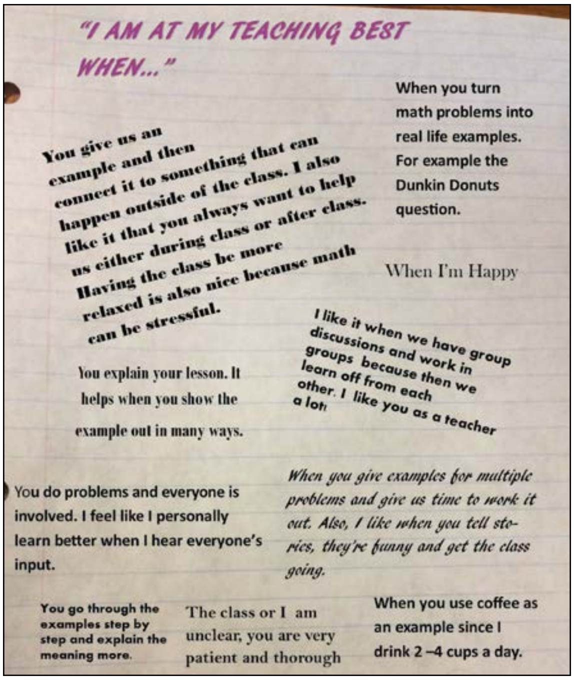


Fig. 4 Students respond to the prompt "I am at my teaching best when . . ."

knowledge inside and outside the classroom. Students' central role in the learning process helped them engage and develop buy-in. The discussion of different reasoning approaches provided opportunities for students to learn from one another, experience growth in their learning, and, consequently, persevere. The last snapshot illustrated how to capitalize on misconceptions to develop fundamental understanding. Making conceptual connections between earlier and later topics strengthened students' mathematical base knowledge.

One important question may come to mind: How do we know we are making a difference? The dramatic transformation described above—from the unnerving first day, to students filling up a board with questions and then confidently communicating mathematically in snapshot 3—reaffirms that we are indeed making a difference. Halfway through every semester I ask students for feedback about what is working for them. This semester I gave them the prompt "I am at my teaching best when . . ." The responses, some of which are seen in **figure 4,** show the impact that these principles have had on these students.

The meaningful mathematical experiences we provide our students truly set the foundation and open the door for their success in future courses. Seeing the pride on their faces as they walk across the stage to receive their graduation certificate is one of the most rewarding feelings a teacher can ever have. This is what I choose to focus on every day that I enter my classroom.

REFERENCES

Bailey, Thomas, Dong Wook Jeong, and Sung-Woo Cho. 2010. "Student Progression in Developmental Sequences in Community Colleges." *Community College Research Center Brief* 45 (September): 1–6.

Ball, Deborah Lowenberg, Mark Hoover Thames, and Geoffrey Phelps. 2008. "Content Knowledge for Teaching: What Makes It Special?" *Journal of Teacher Education* 59 (5): 389–407.

Bishop, Allan. 1985. "The Social Construction of Meaning: A Significant Development for Mathematics Education." *For the Learning of Mathematics* 5 (1): 24–28.

Civil, Marta. 2014. "Why Should Mathematics Educators Learn from and about Latina/o Students' In-School and Out-of-School Experiences?" *Journal of Urban Mathematics Education* 7 (2): 9–20.

Dweck, Carol S. 2007. "Boosting Achievement with Messages that Motivate." *Education Canada* 47 (2): 6–10.

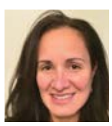
Gutiérrez, Rochelle. 2002. "Beyond Essentialism: The Complexity of Language in Teaching Mathematics to Latina/o Students." *American Educational Research Journal* 39 (4): 1047–88.

Mesa, Vilma, Claire Wladis, and Laura Watkins. 2014. "Research Problems in Community College Mathematics Education: Testing the Boundaries of K–12 Research." *Journal for Research in Mathematics Education* 45 (2): 173–92.

Simon, Martin A., Ron Tzur, Karen Heinz, and Margaret Kinzel. 2004. "Explicating a Mechanism for Conceptual Learning: Elaborating the Construct of Reflective Abstraction." *Journal for Research in Mathematics Education* 35 (5): 305–29.

Strayhorn, Terrell L. 2014. "Modeling the Determinants of College Readiness for Historically Underrepresented Students at 4-Year Colleges and Universities: A National Investigation." *American Behavioral Scientist* 58 (8): 972–93.

U.S. Department of Education, National Center for Education Statistics. 2014. Table 302.10: Recent high school completers and their enrollment in 2-year and 4-year colleges, by sex: 1960 through 2013. *Digest of Education Statistics*. Washington, DC. https://nces.ed.gov/programs/digest/d14/tables/dt14_302.10.asp



RUTH URBINA-LILBACK, rurbina-lilback@nvcc.commnet.edu, is a professor of mathematics at Naugatuck Valley Community College in Waterbury, Connecticut. She is also a doctoral student in curriculum and instruction at the University of Connecticut with research interests in equitable mathematics education and increasing access to higher education.

Apply for Grants and Awards

***The NCTM Mathematics Education Trust** channels the generosity of contributors through the creation and funding of grants, awards, honors, and other projects that support the improvement of mathematics teaching and learning.*

Did you know? As a member of NCTM, you have access to grants and awards to enhance your mathematics teaching and learning. The Mathematics Education Trust (MET) provides funding opportunities to focus on classroom action research, projects that engage students in learning mathematics, professional development, and graduate study to improve teaching skills and classroom practice.

Begin your search at www.nctm.org/met, where you will find current grants and awards grouped by grades pre-K–5, 6–8, 9–12, and more. Click on any title to see a description of the award or grant, comments from a previous awardee, and eligibility and proposal requirements. The following are examples of MET awards:

- **Future Leaders Initial NCTM Annual Meeting Attendance Awards:** Grants of up to $1,200 plus meeting registration provide for travel, subsistence expenses, and substitute teacher costs of members who are classroom teachers and have never attended an NCTM annual meeting.
- **School In-Service Training Grants:** Elementary, middle, or high schools receive up to $4,000 for support of in-service mathematics programs.
- **Mathematics Coursework Scholarships:** Scholarships of up to $2,000 are awarded to classroom teachers working to pursue courses to improve their mathematics content knowledge.
- **Pre-K–6 Classroom Research Grants:** Awards of up to $6,000 support collaborative classroom-based action research in precollege mathematics education involving college or university mathematics educators.
- **Engaging Students in Learning Mathematics Grants:** Awards of up to $3,000 are given to grades 6–8 classroom teachers to incorporate creative use of materials to actively engage students in tasks and experiences designed to deepen and connect their mathematics content knowledge.
- **Connecting Mathematics to Other Subject Area Grants:** Awards of up to $4,000 are awarded to grades 9–12 classroom teachers to develop classroom materials or lessons connecting mathematics to other disciplines or careers.

A proposal to the Mathematics Education Trust is typically no longer than five pages. Two deadlines occur per year: the first week of May and the first week of November. The MET Board of Trustees reads proposals and notifies awardees by letter in July and February.

The MET Board of Trustees strives to distribute all awards in each funding cycle. Some funds go unused because applications are not received for all grants each year. Take advantage of this opportunity to obtain funding for you or your school. Visit the website on a regular basis to check for updates.

The MET also accepts donations and is always looking to establish new grants and awards. MET is an asset of NCTM and can be an asset for you.

NCTM® | MATHEMATICS EDUCATION TRUST

Visit www.nctm.org/met