A CASE STUDY ON A DIVERSE COLLEGE ALGEBRA CLASSROOM: ANALYZING PEDAGOGICAL STRATEGIES TO ENHANCE STUDENTS' MATHEMATICS SELF-EFFICACY

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Shifting demographics show America rapidly diversifying, yet research indicates that an alarming number of diverse students continue to struggle to meet learning outcomes of collegiate mathematics curriculum. Consequently, recruitment and retention of diverse students in STEM majors is a pervasive issue. Using a sociocultural perspective, this study examined the effect of two pedagogical strategies (traditional instruction and cooperative learning) in a diverse College Algebra course on enhancing students' mathematics self-efficacy. Particular attention was paid to investigating the role student discourse and interaction play in facilitating learning, improving conceptual understanding, and empowering students to engage in future self-initiated communal learning. The goal is to develop an effective classroom model that cultivates advancement in content knowledge and enculturation into the STEM community, culminating in a higher retention rate of diverse students in STEM. Preliminary data analysis suggests that a hybrid model encompassing both traditional instruction and cooperative learning successfully enhances students' self-efficacy.

Key words: Diversity, Pedagogy, College Algebra, Sociocultural Theory, Self-Efficacy

Research indicates that an alarming number of diverse[1] students struggle to meet learning outcomes in mathematics (National Center for Education Statistics [NCES], 2009; Trends in International Mathematics and Science Study [TIMSS], 2007). This is a critical issue because according to the U.S. Census, the racial and ethnic population of the U.S. continues to expand considerably. However, many culturally diverse students struggle in mathematics, and therefore, elect not to major in and successfully complete degrees in Science, Technology, Engineering, or Mathematics (STEM) disciplines. For the U.S. to remain competitive in the world market of global technology, an increase in minority STEM leaders is essential and must be addressed.

Although mathematics educators (Boaler & Staples, 2008; Gutierrez, 1996; Gutstein, 2003) have performed extensive research on studying various techniques to help diverse students thrive at the K-12 level, significantly less research has been done at the college level. Analyzing college students is equally imperative because numerous high school graduates enter college mathematically underprepared (Bettinger & Long, 2006), lacking the confidence they need to succeed, and fail to complete degrees in STEM majors. Therefore, the specific problem I will focus on is how to more efficiently close the achievement gap for diverse college students by increasing their mathematics self-efficacy[2] (Bandura, 1977, 1995).

Research studies demonstrate that students with high self-efficacy perform better academically than those with low self-efficacy (Multon, Brown, & Lent, 1991; Pajares &

[1] I use the term *diversity* as defined by The National Council for Accreditation of Teacher Education (2008): "differences among groups of people and individuals based on ethnicity, race, socioeconomic status, gender, exceptionalities, language, religion, sexual orientation, and geographical area."

[2] Self-efficacy shall be understood as a person's confidence in accomplishing a given task.

Graham, 1999). According to Hackett and Betz (1989), even when variables such as mathematics aptitude, gender, and anxiety are controlled, self-efficacy beliefs are predictive of students' choice of major and academic performance. I take the perspective that obtaining high self-efficacy will benefit students not only in the short-term (i.e. passing classes), but have significant long-term impacts as well. Students with high self-efficacy are more likely to persist and graduate in STEM-related fields, which will ultimately lead to diversifying STEM education. To accomplish that, teachers play an instrumental role in implementing effective pedagogical strategies and establishing a supportive learning environment.

Over the years, teachers have implemented various pedagogical methods in mathematics classrooms to heighten student learning and enhance self-efficacy. Commonly employed pedagogies include variations on *traditional instruction* (where teachers exclusively lecture and students work independently). Through independent learning, students can increase their confidence levels by solving problems without aid. Another type of pedagogy is *cooperative learning* or peer interaction in collaborative groups, which has since emerged as one of the prominent methods in developing student learning and confidence. The NCTM Standards asserted, "Whether working in small or large groups, [students] should be the audience for one another's comments – that is, they should speak to one another, aiming to convince or to question peers" (NCTM, 1991, p. 45). Peer interaction provides students the opportunity to collaborate with their classmates, explain their solution methods, and construct knowledge while participating in a community of practice (Lave & Wenger, 1991). I hypothesize that working in collaborative groups will promote student engagement in discussions, expand learning by combining each member's knowledge base, and encourage students to teach and learn from their classmates, which can ultimately increase self-efficacy such that students persist in STEM.

Participants (n = 10) for this study were enrolled in one College Algebra course consisting of diverse undergraduate students. This course was set up as a hybrid model where during each class period students learn in two settings: traditional instruction and cooperative learning. In the traditional setting, students learn independently (lecture-style) with little or no interaction with fellow peers. In cooperative learning, students work together in groups while freely interacting with one another to examine and complete discussion-provoking activities. I investigate the role student discourse plays in facilitating learning and improving conceptual understanding; subsequently I specifically analyze *how* students increase their self-efficacy in the classroom.

This study explores the following research questions:

1) What do individual students perceive to be the benefits and challenges of traditional and collaborative pedagogies, particularly with respect to enhancing their self-efficacy?
2) What evidence exists indicating the role of discourse in improving diverse students' learning outcomes?
3) What are the implications of addressing diverse perspectives when implementing either pedagogy?

I have framed this research study using a sociocultural theoretical perspective. Operating under a sociocultural perspective, I am able to reinforce the idea that learning is a co-constructed process that occurs and is influenced by multiple contexts (Vygotsky, 1978). A sociocultural perspective has crucial implications for informing the study design, type of data to be collected, and how the data is analyzed. For example, to capture the multiple contexts of students learning mathematics, it behooved me to collect data on *how* students perceived their learning in different settings (traditional vs. cooperative). Therefore, I meticulously deconstructed and analyzed group interaction and discourse as students worked to solve mathematical problem sets.

Given my goal of comprehending the highly complex phenomena of teaching and learning mathematics, I collected data using multiple sources in a mixed-method research design. The College Algebra course I studied with diverse students (n = 10) took place during the summer term of 2012. Data were collected at a medium sized public university in the Pacific Northwest. While this study is a mixed-method design, to most efficiently attend to the research questions, the majority of the data were collected qualitatively. Each data source (classroom observations, video data, interviews, surveys, journals, artifacts, and reflexivity) was analyzed using standard procedures of coding and/or statistical analysis. To support the qualitative data and strengthen findings, I administered the Mathematics Self-Efficacy Scale (Hackett & Betz, 1989) as a pre/post survey (reliability coefficient alpha of .96 (Hall & Ponton, 2002)) to determine whether students' self-efficacy increased or decreased throughout the study. This quantitative survey was used to support the qualitative data. I administered pre/post interviews with all 10 participants, observed them during class, and all 10 students completed the surveys.

To strengthen the validity and reliability of the study, I focused on three strategies: First, triangulation (Denzin & Lincoln, 1998) was used throughout the analysis process to understand each source in relation to each other, elucidate clear trends and themes, and fortify the credibility of the study. Second, I performed member checks (Lincoln & Guba, 1985) with participants to ensure the study's trustworthiness. Third, I completed inter-rater reliability (Mays & Pope, 1995) with an experienced colleague to establish reliability among coding.

Preliminary findings suggest that a hybrid course using both traditional instruction and cooperative learning is successful because it attends to the students' various learning styles. Class observations, video recordings, interviews, and journals indicate that through a hybrid model, different students gain from different parts of the course. A hybrid course is beneficial because it is as diverse as the students. Students pointed out that in cooperative learning, instead of diminishing learning by "relying on someone else" it was advantageous to "bounce ideas off of each other," which garnered "multiple viewpoints." In traditional instruction, students acknowledged the "possibility of getting behind if you don't understand what's going on," but it also "teaches you to learn how to do things individually." I performed a paired sample t-test on the survey data, indicating that students' self-efficacy increased significantly during the course.

The results of this study show the usefulness of a hybrid classroom model for attending to individual student needs and enhancing their self-efficacy. The outcomes also suggest the hybrid model would be beneficial to introductory courses, where students of varied backgrounds congregate to become proficient with foundational concepts. Moreover, this collection of student perspectives offers evidence that components of the hybrid can be optimized for full effect on learning outcomes. For instance, grouping students whose learning styles mesh well together could lead to heightened discourse and problem solving skill development. For diverse STEM students, this setting is a venue in which to strengthen content knowledge while participating in the discourse of the STEM communities to which they strive to gain membership. Increasing diverse students' self-efficacy in this way can lead to similar future interactions and identification with peers and authorities in STEM fields; an important consequence, as engagement and self-identification with STEM professionals has been reported to lead to an increase in the likelihood of retention (Carlone & Johnson, 2007).

Questions: 1) How can I conduct a similar study on a larger class? What challenges come with a larger class, and what can I do to overcome them? 2) How do the students' perspectives mesh with your understanding of the benefits and challenges of the two pedagogies?

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